DOCUMENT RESUME

ED 354 159 SE 053 297

TITLE	Teach with Energy! FUNdamental Energy, Electricity, and Science Lessons for Grades K-3.
INSTITUTION	National Energy Foundation, Salt Lake City, UT.
PUB DATE	90
NOTE	168p.; For grades 4-6 lessons, see SE 053 298.
AVAILABLE FROM	National Energy Foundation, 5160 Wiley Post Way, Suite 200, Salt Lake City, UT 84116.
PUB TYPE	Guides - Classroom Use - Teaching Guides (For Teacher) (052)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	*Electricity; *Elementary School Science; Energy Conservation; *Energy Education; Environmental Education; Food; Fuels; Mathematics Instruction; *Primary Education; *Science Activities; *Science Education; Science Instruction; Social Studies
IDENTIFIERS	Energy Consumption; Energy Conversion; Energy Sources

ABSTRACT

This book is an energy, electricity, and science resource guide for teachers of grades K-3. The types of energy covered are: coal, oil, natural gas, nuclear energy, renewable energy sources, electricity and food. Thirty-one interdisciplinary energy lessons are the heart of the book. Each lesson is teacher tested and can be incorporated into the agenda for mathematics, social studies, or science instruction. The lesson format highlights all of the information needed to assess at a glance the lesson's place in an instructional program. All the lessons are tied into the National Energy Foundation's conceptual framework for energy education. Each lesson is keyed to a specific energy concept within the framework's broad categories: energy sources, uses and applications of energy, energy forms and conversions, environmental and economic impacts, limits of energy resources and supply, energy future, and energy conservation and management. Contents of each individual lesson are: disciplines addressed (science, art, language arts, etc.); appropriate grade level; time required; concept addressed; activity goal; materials needed; "what to do"; and evaluation idea. Background information is provided to help teachers answer student questions. Activities accompanying the lessons include: pages to color; flashcards; songs; and puzzles. Fifteen similar activities are included in a section "just for fun." An energy glossary concludes the document. All activities are reproducible for classroom use. (PR)

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TEACH WITH ENERGY!

Fundamental Energy, Electricity and Science Lessons for Grades K-3

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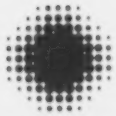
TEACH WITH ENERGY!

FUNdamental Energy, Electricity and Science Lessons for Grades K-3



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THE NATIONAL ENERGY FOUNDATION

The National Energy Foundation (NEF) is a unique nonprofit educational organization devoted to the development of instructional materials and teacher and student educational programs dealing with energy. NEF is supported by resources from business, government and education. NEF's primary concern is to present energy, science, technology and contemporary issues accurately and objectively.

ACKNOWLEDGEMENTS

The National Energy Foundation acknowledges the contribution of Virginia Power/North Carolina Power in the revision and development of these instructional materials. NEF recognizes the talents and expertise of numerous teachers, curriculum development specialists, reviewers, editors, typesetters and printers who assisted in this effort. Without their support and assistance this work would not have been possible.

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Warning: Some of the activities are potentially hazardous due to the use of flammable substances and/or heat. Please exercise extreme caution. Check your local and state laws governing the use of flammable materials in the classroom. In addition, always be alert to possible electrical hazards. Each school year should begin with a review of the safe use of electricity, and each activity involving the use of electricity should be preceded by a reminder of safety procedures.

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TEACH WITH ENERGY! READ THIS FIRST!

Welcome to Teach With Energy!, an energy, electricity, and science resource guide for teachers of grades K-3. The pages that follow provide everything you'll need to be comfortable with teaching energy topics all year long. Teacher-friendly features, described below, are built into the book:

Simple, Fun, Idea-Packed Energy Lessons. Thirty-one interdisciplinary energy lessons, outlined on page 32, are the heart of Teach With Energy! Each is teacher-tested and can be easily incorporated into the agenda for mathematics, social studies, or science instruction. The lesson format highlights all of the information needed to assess at a glance the lesson's place in your instructional program.

All lessons are tied to a conceptual framework. Beginning on page 2, you'll find the National Energy Foundation's conceptual framework for energy education. Developed and refined by teachers over a 12-year period, this framework offers a comprehensive approach to introducing students of all ages to important concepts about energy. Each energy lesson is keyed to a specific energy concept within one of seven broad categories: Energy Sources, Uses and Applications of Energy, Energy Forms and Conversions, Environmental and Economic Impacts, Limits of Energy Resources and Supply, Energy Future, or Energy Conservation and Management.

Background information is at your fingertips. Whether it's "What is nuclear power?" or "How does a light bulb work?" — we've designed Teach With Energy! to provide you with the answers to the toughest questions your students may ask. The extensive "Energy Basics" section (pages 9 - 29) and the "Energy Glossary" (pages 154 - 160) offer in-depth coverage of a wide array of energy and electricity topics.

We've included some activities that are truly "just for fun." In addition to the energy lessons, you'll find 15 simple energy activities at the end of the book (pages 134 - 151) — just perfect to have on hand for the student who finishes an assignment before the others, to use as a homework page to complete with parents, or to add some fun to a rainy day. Enjoy!

Teach With Energy! is reproducible. No need to send away for energy publications; all of the coloring books, puzzles, and handouts needed for a K-3 energy unit are included in Teach With Energy! Make as many copies as you need for classroom use.

Let us know how you like Teach With Energy! We'd enjoy hearing from you.

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Conceptual Framework

Sources of Energy

Sources

Program Goal 1: The learner should understand that there are many sources of energy.

Concept 1: The sun is the primary source of the earth's energy.
Concept 2: Natural and human processes are constantly forming energy resources.
Concept 3: Energy sources can be classified in many different ways.
Concept 4: Each source of energy can be used in many ways.

Uses and Applications of Energy

Uses

Program Goal 2: The learner should understand that there are many uses of energy.

Concept 1: All living things and natural processes require energy.
Concept 2: Each form of energy can be used in many ways.
Concept 3: Some human activities and technologies use more energy than others.
Concept 4: Every energy use decision affects standards of living and quality of life.
Concept 5: Laws and regulations are made to control energy development and use.
Concept 6: There are health and safety factors associated with the development and use of energy resources.
Concept 7: Many occupations have resulted from the use of energy sources.

Energy Forms and Conversions

Conversions

Program Goal 3: The learner should understand what energy is and how it can be converted from one form to another.

Concept 1: Energy is the capacity to do work.
Concept 2: Energy occurs in many forms.
Concept 3: All energy conversions are subject to natural laws.
Concept 4: There are man-made and natural energy conversion systems.
Concept 5: The efficiency of energy conversion systems differs.
Concept 6: There are benefits and problems associated with each energy conversion process.
Concept 7: Changes in energy conversion technology have resulted in technological and industrial change.

Environmental and Economic Impacts of Energy

Impacts

Program Goal 4: The learner should understand that the development of energy resources and the use of these resources create impacts on environmental and economic systems.

Concept 1: Energy resource development and use impact environmental conditions.
Concept 2: Industrial societies have a greater impact on the environment than do agrarian societies.
Concept 3: The use or nonuse of an energy source requires environmental and economic trade-offs.
Concept 4: Compromise may be necessary to resolve conflicts concerning the environmental impact of energy use.
Concept 5: Laws and regulations direct the nature and extent of impacts resulting from energy resource development and use.
Concept 6: Economic factors influence energy source discovery, development, distribution and use.
Concept 7: Energy costs are related to the cost of energy resource exploration, recovery, refining, pollution control and transportation.
Concept 8: Energy conservation efforts interact with economic conditions.

Limits of Energy Resources and Supply

Limits

Program Goal 5: The learner should understand that the amount of energy resources and their availability for human activity vary.

Concept 1: Energy resources are unevenly distributed.
Concept 2: High grade (concentrated) energy resources occur in relatively small amounts compared to average and lower grade energy resources.
Concept 3: It takes energy to obtain energy.
Concept 4: All energy resources have limits to their usefulness.
Concept 5: Some energy resources are rapidly renewed while others are renewed so slowly as to be practically nonrenewable.
Concept 6: The availability of the earth's resources and the per capita consumption intersect to determine the limit of the human population the world can support.
Concept 7: The availability of energy resources influences social, political and cultural growth and well-being.
Concept 8: The availability of energy resources is influenced by availability of technology.
Concept 9: Social decisions influence the availability of energy resources.
Concept 10: Economic factors limit energy development and use.
Concept 11: Future technologies may be limited by existing resources.

Energy Future

Future

Program Goal 6: The learner should understand that energy sources, technology, and consumption patterns of the future may be different from those of the past or present.

Concept 1: New energy technologies may be developed in the future.
Concept 2: New energy resources may be discovered in the future.
Concept 3: Different consumption practices may alter future demands on energy resources.
Concept 4: Competition for energy resources will influence future relationships between nations.
Concept 5: Energy availability will affect future lifestyles and cultural conditions.
Concept 6: Future energy development will result in the loss of some employment opportunities and the addition of others.
Concept 7: New energy resource technologies are continually being developed.

Energy Conservation and Management

Conservation

Program Goal 7: The learner should understand the value of wise and efficient management practices which extend the useful life of the earth's energy resources.

Concept 1: There are various ways to conserve energy.
Concept 2: Attitudes, beliefs, values and economic conditions influence the practice of energy conservation.
Concept 3: The implementation of energy conservation practices is affected by social and political decisions.
Concept 4: Energy conservation practices affect lifestyles, quality of life and standard of living.
Concept 5: Technological development affects energy conservation options.
Concept 6: Some energy sources are more efficient or convenient for certain uses than others.

Energy Basics

ENERGY BASICS
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The Importance Of Energy

Introduction

Stated simply, energy is the ability to do work or produce change. Like many other normally-occurring facets of our lives, we tend to take energy for granted. But its importance should not be overlooked, because nothing happens without energy.

For example, the act of reading this page requires a complex energy chain. The light which illuminates the words is energy. Energy was necessary to run the machine that printed the page. The ink and paper were produced by energy. It even takes energy to turn these words into meanings in the human mind.

While energy is responsible for making ordinary events such as these possible, its true value is far greater and more basic. In many ways, we depend on energy for our very existence.

Without energy, it would be impossible to produce the food we eat, process and package it, deliver it to stores and, for that matter, consume and digest it.

Similarly, energy is essential to produce warmth, shelter, clothing and other necessities of life. To perform its important work, energy may appear in any of several forms.

What are the forms of energy?

Energy is all around us, all of the time. It may, however, be known by different names, depending on its source. Light, whether it comes from the sun or from a lightbulb, is radiant energy. Gravitational energy is the force which holds objects to the earth. Food and fuel contain stored chemical energy, while objects which are hot contain thermal energy. A machine with moving parts is said to have mechanical energy. Charged objects are filled with electrical energy. And radioactive objects contain nuclear energy.

Another important concept of energy is that it may change forms. Imagine, for instance, that you have a battery-powered robot that sweeps the floor. When you switch it on, it starts to sweep. What happened is that the chemical energy in the battery produced electrical energy in wires, which was converted to mechanical energy in the moving parts of the robot.

What are the sources of energy?

Sunlight, fuel of all types, wind and water are among the list of usable energy sources.

While energy is present in many sources, it may not be working all of the time. Energy in motion is called kinetic energy. Whenever you see something moving or happening, you know that kinetic energy is the force involved. Water flowing over a dam, a person running, a machine in operation are all examples of kinetic energy.

Energy that is not in motion, but could be, is known as potential energy. For example, a piece of firewood contains stored, or potential, energy that is ready to be used.

Without plentiful usable energy sources, life as we know it would grind to a halt.

Is energy important?

Throughout history, the importance of energy has become abundantly clear to developing civilizations. What it comes down to is this: a nation that has many sources of energy is usually highly productive and successful. A nation that can't meet its energy needs has a hard time surviving.

That's why energy conservation and the discovery of new ways to use energy will continue to be major issues of our time. The world is only as safe and secure as its energy supply.

(Adapted from **Energy Readings**, part of the New York Energy Education Project, with permission of the New York Power Pool.)

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Coal

How is coal formed?

Coal is classified by geologists as a mineral. But most minerals, like salt or iron ore, were formed by inorganic matter. Coal, on the other hand, came from organic matter—plants, that lived about 300 million years ago.

During the Pennsylvanian Period in earth's history, the earth was covered with huge swampy forests of giant ferns, reeds and mosses, which grew taller than our tallest trees today. As these plants died and fell into the swamp water, new plants grew to take their place and when these plants died, still others grew. In time, there was a thick layer of dead, decaying plants in the water.

The surface of the earth also changed and dirt washed into the water covering the dead plants, preventing them from completely decomposing. More plants grew but they too died and fell into the water, forming a separate layer of dead decaying plants, which over time was also covered by sediments, preventing complete decomposition. After millions of years many layers had formed, one on top of the other.

The weight of the overlying layers compressed the lower layers of plant matter forming peat. Heat and pressure, caused by the overlying sediments, produced chemical changes in the peat, forcing out oxygen and hydrogen leaving behind rich carbon deposits—coal.

Geologists estimate that a layer of plants 20 feet thick may have been required to form a coal seam one foot thick. Coal seams vary in thickness, ranging from only a few inches thick to more than 100 feet in thickness.

Where is coal located in the United States?

Coal represents the United States' most abundant energy source. The U.S. Geological Survey has identified 1.7 trillion tons of coal resources in the United States. If yet undiscovered, but likely deposits are added, potential reserves may be as high as 4 trillion tons. The World Energy Conference estimated that the coal reserve of the United States accounts for two-thirds of the free world's total and nearly 28 percent of the total world recoverable coal. By comparison, Saudi Arabia has about 23 percent of the world's proven petroleum reserves.

The United States has about 490 billion short tons of demonstrated reserves, which by definition are potentially mineable on an economic basis with existing technology. At current domestic consumption levels, this is enough coal to last 300 years.

Measurable quantities of coal are found in 36 states, and in 31 states the coal is considered mineable. At present, coal mining occurs in 26 states, including areas of Appalachia, the Midwest, the Central and Northwestern Plains states, the Rocky Mountains and the Pacific Northwest.

How is coal mined?

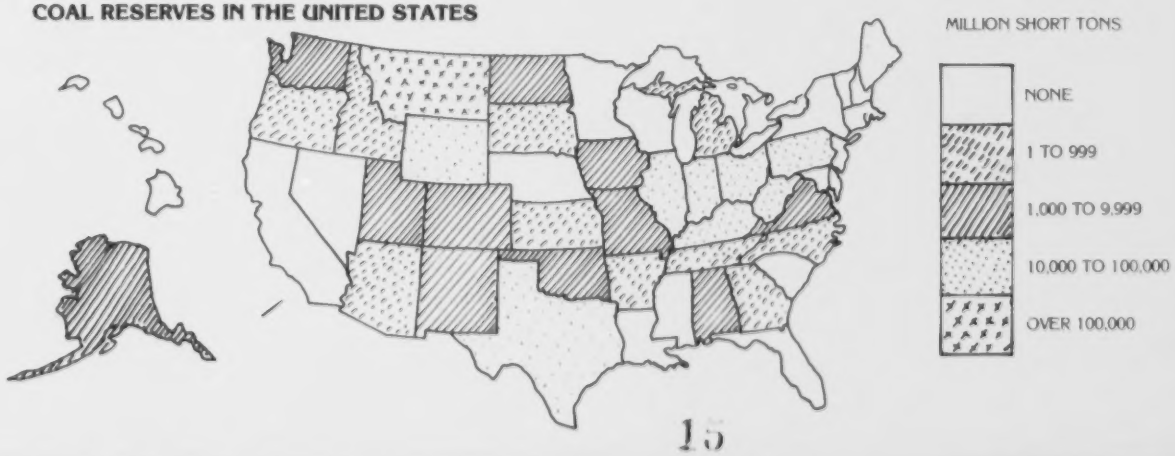
As was the case 50 years ago, most coal is produced from two major types of mines—underground and surface. But the methods for recovering coal from the earth have undergone drastic changes in the past 25 years, as a consequence of technological advances.

Fifty years ago when most coal mining was done manually, underground mines accounted for 96 percent of the coal produced each year. Today, almost 60 percent is produced from surface mines. Most underground mines in the United States are located east of the Mississippi River, although there are some in the West, particularly in Utah and Colorado.

More than two-thirds of the coal produced underground is extracted by continuous mining machines in the room-and-pillar method. The continuous mining machine contains tungsten bits on a revolving cylinder. The continuous miner breaks the coal from the face and then conveys it to a waiting shuttle car which transports it to the conveyor belt to be moved to the surface. No blasting is needed. After advancing a specified distance, the continuous miner is backed out and roof bolts are put in place. The process is repeated until the coal seam is mined.

Another method, called longwall mining, accounts for about 20 percent of production. This method involves pulling a cutting machine across a 400 to 600 foot long face (longwall) of the coal

COAL RESERVES IN THE UNITED STATES



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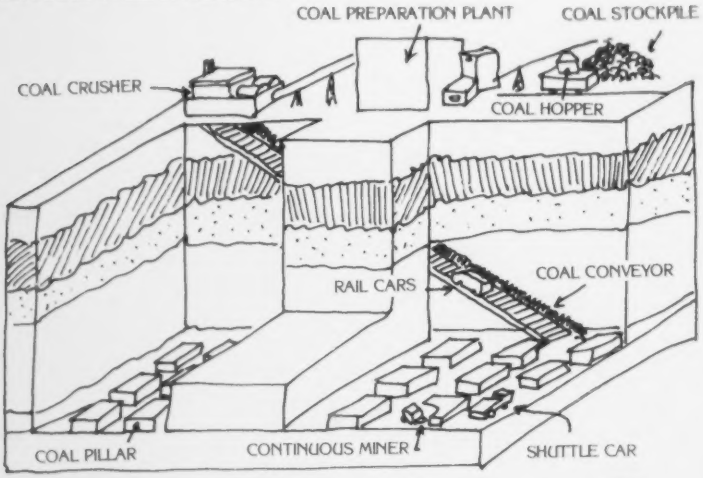
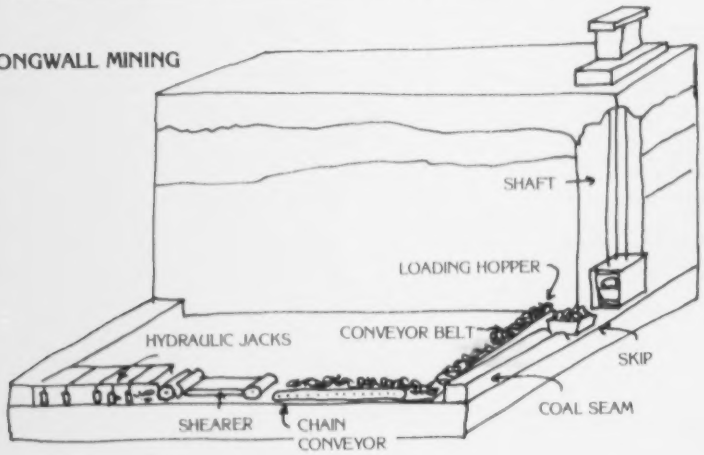
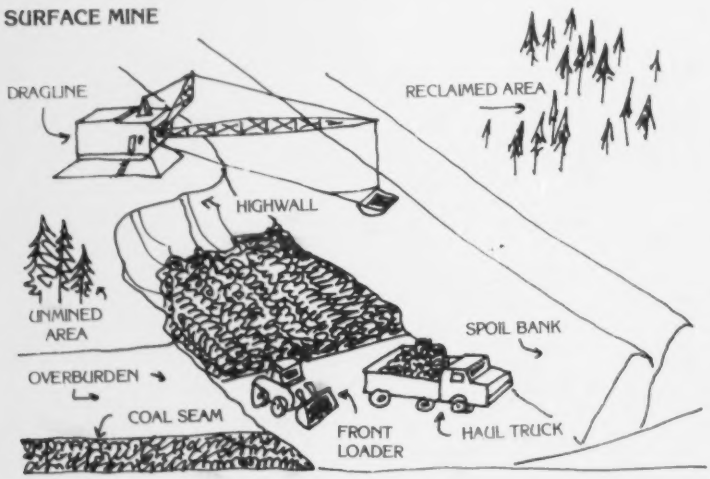
ROOM AND PILLAR METHOD



LONGWALL MINING



SURFACE MINE



seam. This machine has a revolving cylinder with tungsten bits that shear off the coal. The coal falls into a conveyor system which carries it out of the mine. The roof is supported by large steel supports, attached to the longwall machine. As the machine moves forward, the roof supports are advanced. The roof behind the supports is allowed to fall. Nearly 80 percent of the coal can be removed using this method. The remaining 11 percent of underground production is produced by conventional mining which uses explosives to break up the coal for removal.

Half of the mineable surface coal in the United States is located in the West, but significant amounts are also present in Appalachia and midwestern states. Surface mining is used when the coal seam is located relatively close to the surface, making underground mining impractical.

Before a company can surface mine, it must gather information about the site regarding growing conditions, climate, soil composition, vegetation, wildlife, etc. With this information, the company then applies to the federal government for a permit to mine. The company must post a bond for each acre of land it mines to assure that it will be properly reclaimed.

Most surface mines follow the same basic steps to produce coal. First, bulldozers clear and level the mining area. The topsoil is removed and stored for later use in the reclamation process. Many small holes are drilled through the overburden (dirt and rock above the coal seam) to the coal seam. Each is loaded with explosives which are discharged, shattering the rock in the overburden. Giant power shovels or draglines clear away the overburden until the coal is exposed. Smaller shovels then scoop up the coal and load it onto trucks, which carry the coal to the preparation plant.

Once the coal is removed, the land is regraded to the desired contour and the topsoil is replaced. Native vegetation and/or trees are planted. Coal companies operating surface mines must comply with strict requirements and regulations of the Federal Surface Mining Control and Reclamation Act. A crucial part of the surface mining process is restoring a mined site to acceptable ecological conditions, which means it must be made as productive as it was prior to mining. There are farms, parks, wilderness and recreation areas on what were once surface mines.

The major stigma with the coal industry today is the abandoned or "orphan" mines of the early coal mining years.

These orphan mines are systematically being reclaimed under the Surface Mining Act. The Surface Mining Act taxes coal producers at the rate of 35 cents a ton for surface mined coal, 10 cents a ton for lignite mined coal, and 15 cents a ton for underground mined coal. The tax is paid to the government and is used to reclaim the orphaned mines.

How is coal used?

Coal has four major markets: electric utilities, industrial/retail users, the steel industry and exports.

Electric utilities use more than 86 percent of the coal produced in the United States. Upon close examination, it is clear that price has been a major deciding factor in coal's increased use. More than 57 percent of the electricity generated in the United States comes from coal.

In an electric power plant, coal, like oil and natural gas, is burned to produce heat. The heat is used to change water into steam. The steam then turns the blades of a turbine, spinning the generator, producing electricity. Before the coal is burned it is crushed and pulverized to the consistency of face powder.

Coal's second largest market is industrial and retail users. Among the industries using coal, the largest consumers are chemical manufacturers, users of stone, clay and glass, paper mills, primary metal industries and the food industry. Industry uses coal as a chemical feedstock to make dyes, insecticides, fertilizers, explosives, synthetic fibers, food preservatives, ammonia, synthetic rubber, fingernail polish, medicines, etc.

The third largest market is the iron and steel industry, where coal is used to make coke. Coke is derived from bituminous coal through heating in airtight ovens. The lack of air prevents the coal from burning and converts some of the solids to gases leaving coke.

The fourth segment to market is exports. The top five foreign markets are Canada, Japan, Italy, Netherlands and Brazil. U.S. coal distributed to foreign countries in 1988 totaled 95 million short tons (76 million to overseas destinations and 19 million to Canada). Major reasons for the decline in United States' coal exports from the all-time high of 112.5 million tons in 1981 are stiff competition in the international marketplace and worldwide economic conditions.

How does burning coal affect the environment?

Coal is a chemically complex fuel. Whenever it is burned, gases are given off and particles of ash, called "fly ash," are released. The sulfur in coal combines with oxygen to form sulfur dioxide, which can be a major source of air pollution if emitted in large enough quantities.

Today, many of the effects of coal burning have been reduced significantly or eliminated. Three basic methods are used to reduce the quantity of pollutants resulting from coal combustion.

The first, a pre-combustion method for removing contaminants from coal, is coal cleaning or "coal benefication." In coal cleaning the coal is crushed and screened from impurities. Further processing utilizes the different gravities of coal and impurities to separate them in a liquid medium. Coal cleaning can remove the pyritic sulfur, which can reduce sulfur content by as much as 30 percent.

The second, a post-combustion method, uses flue gas desulfurization systems, commonly called scrubbers. According to the Electric Power Research Institute, scrubbers can remove more than 90 percent of the sulfur dioxide emissions from coal combustion. The flue gas is sprayed with a slurry made up of water and an alkaline agent—usually lime or limestone. The sulfur dioxide reacts chemically, forming calcium sulfate or calcium sulfite. This is removed and disposed of as a wet sludge. There are currently 134 scrubbers operated by the electric utility industry in the United States.

The final method for reducing or eliminating pollution from coal combustion is the use of electrostatic precipitators or baghouses which are used to remove fly ash. In electrostatic precipitators the particulate matter is given an electrical charge. The charge attracts it to a collector plate, where the particles are collected, preventing their discharge into the atmosphere. In a baghouse, the particulate matter is filtered out as it passes through a series of filters, similar to a household vacuum cleaner.

The two major environmental concerns today dealing with the use of coal are: increases in atmospheric carbon dioxide levels and acid rain. Much remains to be learned about the relationship between fossil fuels (coal, oil, natural gas) and the environment. It is believed that combustion has partially contributed to the increase in atmospheric carbon dioxide levels. Increased atmospheric carbon dioxide levels may result in warmer climates due to the "greenhouse effect." The increase in atmospheric carbon dioxide prevents heat from escaping from the earth, thus warming the atmosphere.

The combustion of coal also appears to contribute to acid rain, although precise measures of the scope and seriousness of acid rain are not clear or well understood. What is clear is that further study of the phonomenon is necessary.

There is an interesting riddle to the acid rain phenomenon, and that is that acid rain damage has occurred during periods when sulfur dioxide discharges have declined or remained stable (sulfur dioxide is considered to be the principal cause of acid rain).

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Oil

What is oil?

Oil is naturally occurring and is often referred to as petroleum. Crude oil or crude is unrefined oil or petroleum.

Oil is a mixture of hydrogen and carbon compounds referred to as hydrocarbons. Thousands of different hydrocarbons make up crude oil. The simplest or basic hydrocarbon unit (molecule) is methane or natural gas (CH_4). Hydrocarbons occur as liquids, gases or as solids like gilsonite. The longer hydrocarbon chains are more likely to be liquids.

It is thought that petroleum originated from tiny marine plants and animals (biotic material) that inhabited the earth in prehistoric times. Through time, the tiny marine plants and animals were buried by ocean sand and silt. Over time, the pressure and heat transformed the biotic material into petroleum.

As the biotic material changed from a solid to a gas or a liquid, it began to migrate, being propelled by water or capillary action through the porous marine sediments. In some instances, the petroleum migrated to the earth's surface. Petroleum migrates upward until it is trapped by a non-porous rock structure called a cap. This specific geologic formation is referred to as a "trap." It is these subterranean traps that are sought by the oil industry. Petroleum then is associated with porous sedimentary rock layers and fossilized marine life.

How is crude oil refined?

At a refinery, crude oil is distilled or separated into its components or fractions. Distillation involves boiling the petroleum, drawing off the vapors, and then condensing the vapors. The different hydrocarbon compounds that make up petroleum vaporize at different temperatures, thus when they are condensed they separate out into different fractions. Fractions represent the diverse range of products that can be obtained from petroleum.

How is oil located ?

One of the most accurate exploration methods is seismic technology. In seismic technology, sound waves, created by explosives detonated either on the earth's surface or underground, are sent into the earth and are reflected back by the rock layers. The reflected sound waves are recorded by seismographs. Seismographs are similar to instruments used to measure earthquakes. The reflected sound waves are received by geophones, which transmit the sound waves to a seismograph located in a truck. The particular rate at which the sound waves are reflected create a picture of the underground geology and possible location of oil traps.

Even after the seismic picture is assimilated and analyzed by geophysicists, there is no guarantee of discovering oil. At best, the seismic picture can provide only a guess to what lies beneath us.

Occasionally, oil companies drill for oil in areas where oil or natural gas has not been discovered. Wells drilled in this fashion are known as "wildcat" wells.

What processes are involved in oil drilling?

Before exploration can begin, energy companies need to obtain permits and drilling rights from landowners. Leases might be purchased, or a development agreement reached, with the landowner often receiving royalties if oil is discovered.

Before drilling equipment can be brought on site, preparatory work is required, such as road building, land clearing or housing development for workers.

In 1859, Edwin Drake, a retired railroad engineer, tried to drill for oil. He used a rig that punched or pounded a hole 69½ feet deep. The pounding pulverized the rock and soil, which was removed by flushing the hole with water. Today's primary form of drilling is rotary drilling. Drill bits are used to grind or bore through the rock. As the drill bit is lowered into the earth, pipe stems are added to the top. Drilling usually runs 24 hours per day until the well is completed. The average well today runs a mile deep. On the Overthrust Belt (Utah and Wyoming), it is common to find wells drilled between 8,000 and 15,000 feet deep because of the folded and faulted rock layers.

An important part of the drilling process is the "mud," a mixture of water, clay, and chemical additives which is pumped into the well during drilling. This constantly circulating liquid cools the drill bit and carries debris out of the well. It also prevents the drilled area from collapsing around the drill pipe and serves to control the natural pressures within the well.

Most onshore rigs are portable and include tall derricks that handle the tools and equipment that descend into the well. Offshore drilling may be done from bottom-based platforms, drill ships, or submersible platforms. Each is self-contained with its own set of equipment. Workers and suppliers are ferried by boat or helicopter to the rig.

Gushers — what caused them?

After petroleum is discovered, the underground pressure forces it to the surface. The days of the "gushers," when oil would explode to the surface, are gone. Each well contains blowout preventers which automatically shut off the flow of gas or oil should well pressure change, preventing gushers, protecting the environment, and preserving the precious fuel.

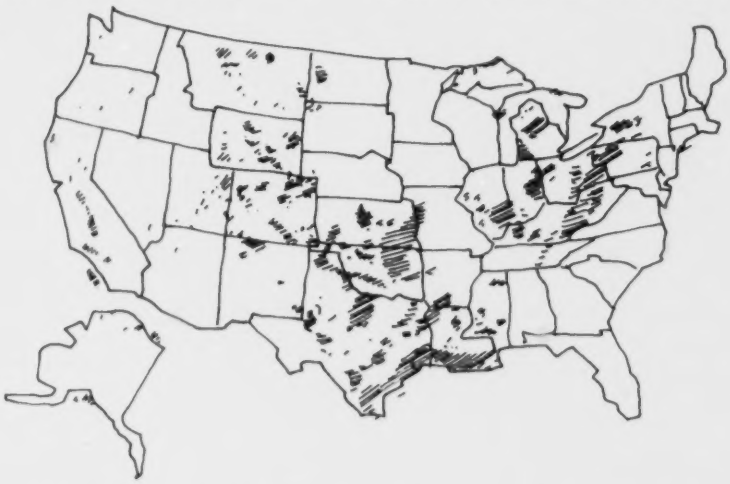
How is oil transported to market?

Three-fourths of the domestic crude oil and a third of the refined products in the U.S. are transported by pipeline. Over 1.2 million miles of pipeline connect production sites with refineries and the petroleum market.

Crude from the Overthrust Belt (Utah and Wyoming) is transported by pipeline to refineries serving the Midwest and

OIL AND GAS FIELDS
IN THE UNITED STATES

FROM THE AMERICAN GAS ASSOCIATION



Western markets. Other major pipelines run between Texas and the Northeastern U.S.

Probably the most famous pipeline is the trans Alaska pipeline, which carries crude from the north slope of Alaska, to Valdez in Southern Alaska. The trans Alaska pipeline transports 1.9 million barrels per day, 25 percent of the nation's oil.

Much of the foreign crude used in the United States is brought to American ports by tankers. These "super tankers" are over a thousand feet long and have a capacity to transport more than two million barrels of crude.

On a regional basis, semitank trucks and railroad cars haul petroleum products to consumers or industries that develop and manufacture petroleum-related products.

Where do we obtain oil?

Oil discoveries in the U.S. since the oil embargo in 1973 are numerous. They include the Overthrust Belt of Utah and Wyoming, the Louisiana Trench and its subsequent development into the Gulf of Mexico; and fields off the Texas and California coasts, as well as new fields in Arctic Alaska.

Oil or natural gas is produced in 33 of the 50 states, with Texas still the leader in production. Other top producing states include Alaska, Louisiana, and California.

The largest producers of crude oil and natural gas liquids in 1987 were the U.S.S.R., the United States, and Saudi Arabia.

How is oil used?

Oil has become an integral part of our society. Much of our high standard of living can be traced to the use of petroleum.

At the turn of the century, it was relatively simple to pinpoint the major uses of petroleum. Grease was the major lubricant and kerosene the major illuminant. Coal, eventually to be displaced by petroleum, was the major energy source for heating.

In the 1900s, America became the land of the horseless carriage. The advent of the internal combustion engine to propel the automobile provided a use for what had been a waste product at the refinery—gasoline. Gasoline quickly became an important product of petroleum as automakers adapted engines to utilize this practical fuel.

Today, about 6,000 products are produced, wholly or in part, from petroleum. Among the products derived from petroleum are gasoline, aviation gasoline, jet fuels (highly-refined kerosene), kerosene (now used mostly for cooking, space heaters and farm equipment), diesel fuels (for heavy equipment), fuel oils (for residential and commercial heating, manufacturing processes, and industrial steam and electrical generation), petroleum coke (almost pure carbon which burns with little or no ash), and liquefied petroleum gas (primarily propanes and butanes obtained from refined natural gas). Other products include lubricating oils, greases, waxes, asphalt, nylon stockings, plastics, fertilizers, shoe polish, washing powders, medicines, photographic film, pesticides, insecticides, and waxed paper.

What environmental safeguards exist?

The oil industry is regulated by major federal laws including the Federal Water Pollution Control Act, the Clean Air Act, the National Environmental Policy Act, and the Federal Land Management and Policy Act. These laws govern the amount of emissions that can enter the atmosphere from refineries, the amount of pollutants that can be discharged into waters, roadbuilding, and land restoration after drilling.

Energy companies have been very diligent in making certain they leave a quality environment. But accidents do occur. The 1969 Santa Barbara oil spill, the 1981 Mexico oil spill in the Gulf of Mexico, and the 1989 oil spill near Valdez, Alaska provide examples of the damage that can occur to the environment.

Less obvious environmental damage results from burning petroleum and natural gas.

Automobiles, the primary petroleum consumer in the country, emit carbon monoxide, carbon dioxide, sulfur and nitrogen oxides into the atmosphere from the combustion of petroleum. Industry and homes also emit sulfur when fuel oils are combusted.

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Natural Gas

Introduction

Of the energy sources available, Americans rely on natural gas to supply about 26 percent of their energy needs. This ranks natural gas second in use only to oil which supplies about 43 percent of America's energy needs. Natural gas provides about 42 percent of our industrial needs. Nearly six out of every 10 homes is heated with natural gas and in most cases, is used for cooking, drying clothes, and heating water. Businesses and industries use natural gas in many ways, from cooking in restaurants to fueling high temperature blast furnaces for the manufacturing of steel. In fact, natural gas affects everything we do and use.

What is natural gas?

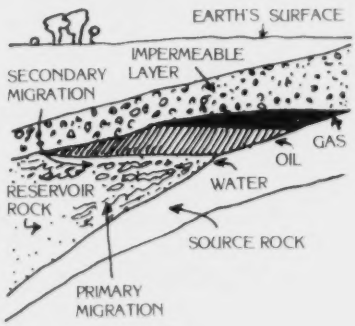
Natural gas has been defined as naturally occurring hydrocarbon and non-hydrocarbon gases found in the porous geological formations beneath the earth's surface. It is made up of about 90 percent methane, with small amounts of ethane, propane, butane, carbon dioxide and nitrogen.

What are the origins of natural gas?

Conventionally, it has been accepted that natural gas is a by-product of the breakdown of marine organisms and/or terrestrial plant debris which accumulated in vast deposits on the bottoms of ancient lakes, rivers and seas. Over time, the deposits were buried by layers of sediment consisting of mud, sand and rock. With each additional layer of sediment the pressure on the organic deposits increased. As pressure and heat from the buildup of sediments increased, chemical changes in the organic deposits took place and a complex, tar-like substance called kerogen was formed. As temperatures continued to increase and the kerogen continued "cooking," more complex compounds of carbon and hydrogen known as oil were formed. Natural gas is generated at the same time as is oil, however, peak generation occurs when oil begins to break down because of high geothermal temperatures, e.g. greater than 205°C (400°F). This range of petroleum (oil and natural gas) generation is called the petroleum window.

As natural gas molecules form, they migrate out of the shaley "source rock" into more porous areas such as sandstone. From there, they eventually make their way to either the earth's surface where they escape into the atmosphere, or they are trapped when their migration path is blocked. In the latter case, impermeable rock layers prevent the molecules from migrating farther and a natural gas accumulation occurs.

NATURAL GAS FORMATION AND ACCUMULATION



In contrast to the biological explanation of the origin of natural gas, the "deep gas theory" speculates that natural gas is derived from non-biological materials that formed the earth billions of years ago. The brainchild behind the deep gas theory is an American named Thomas Gold of Cornell University. In 1979, Gold published the first papers to contend that, "on earth, as on other planets, most hydrocarbons were formed from non-biological sources."

The theory proposes that the earth is made up of primordial materials that combined together in space billions of years ago when the basic structure of the earth evolved. The materials are believed to still be buried far below the earth's crust, where they have been trapped for 4.5 billion years. Cracks and fissures in the earth's crust allow the gases to migrate into reservoirs and to the surface. In this manner, it is believed that the supply of hydrocarbons produced from the primordial material were instrumental in the creation of the earth's atmosphere.

The deep gas theory further proposes that oil molecules are capable of surviving greater temperatures and pressures found tens of miles beneath the earth's surface, and that many of the hydrocarbons that migrate up to the two-to-three-mile depths do in fact break up into methane gas. This would explain the presence of both oil and gas found at two-to-three-mile depths and further theorizes that a much greater supply of oil is present in "deep wells" which range in depth from 50,000 to 60,000 feet and more.

Much of the deep gas theory evolved out of our growing understanding of how the universe and planets are formed, and from information supplied by the space program. For example, when it was learned that many planets contained hydrocarbons in their atmosphere, with little likelihood of ever supporting plant or animal life, the deep gas theory became more credible.

How is natural gas located?

For thousands of years, humans have known of the existence of natural gas and have been able to find it easily in small quantities near the surface of the earth. But as the readily available supplies became scarce, man was forced to search deeper into the earth. By analyzing what was already known about the location and geological formations in which deposits were found, it was determined that natural gas would most likely be found in areas containing source rock, "porous" reservoir rock and favorable trapping mechanisms such as "migration blocks." Based on this knowledge, new methods evolved that would help locate other areas most likely to contain accumulations. At first, fairly simple surface methods including geologic mapping, surveys and aerial photographs where used. But over time

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more sophisticated methods were developed. Some of the methods used today include: (1) magnetic measurement, a measure of the magnetic field of base rock to determine how much sediment is lying above it; (2) satellite imagery, which helps identify surface structures and patterns that aid in the search for probable underlying hydrocarbon deposits; (3) gravity mapping, which determines thickness of the basin or sedimentary rock layer and helps identify base rock topography; and (4) seismic sound wave reflection, which measures the time to various rock units that reflect acoustic energy. These reflections are plotted in terms of time and amplitude creating a "slice of the earth" view.

Once a trap with economic potential is identified, a drill site is selected. A drill rig is contracted to bore through the layers of rock to the desired level, or "target horizon." The rig uses an engine to turn a table, which turns a pipe that has a drill bit attached on the end. With each rotation of the table, the bit at the end of the pipe digs deeper into the ground. During the process, which generally takes a few weeks, drilling mud (bentonite clay with barite added for weight) is circulated through the drill pipe and well bore. The mud cools and lubricates the bit. It also cleans the hole of cuttings and leaves a thin cake around the well bore to prevent caving of rock fragments and loss of water to the formation. The mud is "weighted" to exceed any expected subsurface pressure. Should a reservoir of natural gas, oil or water that contains higher than expected pressures be encountered, more dense mud is immediately added. If this cannot be done in time, then the well is "shut in" using the surface blowout prevention system. This system is a series of valves that allows the driller several options to close off the well depending upon just how deep the high pressure zone was encountered. The drilling mud is then weighted and circulated through the drill pipe and well bore until the natural gas, oil or water-cut mud is removed and the pressure zone is under control. If the target horizon contains commercial quantities of hydrocarbons (oil and/or natural gas), the well is completed for production. If there is no discovery, the well is plugged and abandoned and the site restored to natural conditions. About one out of eight "wildcats" (wells in unproved areas) result in a significant discovery.

How is natural gas processed and distributed?

Once natural gas has been found, it is necessary to process it and distribute it to users. Hundreds of years ago the Chinese used bamboo to pipe natural gas directly from their wells to their cooking pots. And in the early 1820s William Hart, the first person to develop a practical use for natural gas in America, used hollow logs to bring natural gas from shallow wells to street lamps and small nearby businesses. But as Hart and others continued to pioneer the uses for natural gas, it was found that higher quality natural gas and more functional and durable distribution networks were needed. As a result, hollow logs soon gave way to steel and cast iron pipes. Today, natural gas reprocessing plants are used to turn hundreds of thousands of cubic feet of unrefined wellhead natural gas into commercial, high quality natural gas.

Before natural gas is distributed, it must first be sent to a processing or "stripping" plant where it is cleaned and separated. At the processing plant, the natural gas is first sent through a separator where secondary byproducts including oils, impurities and heavier hydrocarbons such as butane, ethane and propane are removed. Most of these byproducts are reprocessed, packaged and sent to market for a variety of different uses.

As natural gas leaves the processing plant it enters a compressor station where it is pressurized for transmission. As the pressure is increased, the volume of natural gas is reduced and more natural gas can be filled into the same unit space, and the pressure needed to move natural gas through the pipelines is achieved. As natural gas flows through the pipeline, some pressure is lost due to fluid friction caused by the natural gas rubbing against the inside walls of the pipe. This loss of pressure is made up at compressor sub-stations located about every 50-to-100 miles along the transmission pipelines. Along the pipelines are valves used to control pressure and cut off flow in an emergency such as a break in the line or a fire.

During the summer months when peak demands are much lower, natural gas can be stored in empty wells, underground caverns, and in liquified form in storage tanks.

How safe is natural gas?

There are a number of properties of natural gas which make this energy form extremely safe. First, unlike other hydrocarbon fuels, natural gas is lighter than air. This permits it to dissipate into the air if a leak occurs. Other hydrocarbons like propane, ethane and butane are heavier than air and will "puddle" if leaks occur.

Secondly, natural gas has a higher combustion temperature than other fuels. Natual gas ignites at 649°C (1,200°F) compared to as low as 371°C (700°F) for some other fuels.

A third inherent property of natural gas that helps provide a safety barrier is the flammability range previously mentioned. If the exact requirement for mixing natural gas and oxygen are not met, combustion cannot occur.

Although natural gas is safe when properly used, it exhibits certain characteristics that make it potentially dangerous. First, if natural gas and the mixture of oxygen are not properly balanced when lit, incomplete combustion will occur and carbon monoxide will be produced. Second, if a leak occurs and supplants all the available oxygen, asphyxiation may occur.

Because of the potential hazards, it is important that the user know how to safely use natural gas and care for natural gas appliances. One of the first steps to prevent accidents from occurring is to ensure that natural gas appliances and equipment have been properly installed, adjusted, vented and inspected. Other safety precautions that should also be taken include the following:

1. Follow manufacturer's instructions for the installation, operation and maintenance of gas equipment and appliances.
2. Keep flammable materials (paints, solvents, cloth, paper) away from appliances.
3. Provide proper ventilation in areas around furnaces, water heaters, dryers, ranges, etc. Many new appliances use an electronic ignition instead of a pilot light.
4. Perform or have performed routine maintenance on appliances to keep them clean and in proper working order.
5. If the flame goes out, turn the gas off, ventilate the area and notify the natural gas company.

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6. Teach children how to use appliances safely and to recognize the smell of natural gas.
7. When lighting a flame, always strike the match first, then turn on the natural gas.
8. Keep fire extinguishers in the vicinity of appliances with open flames.

If a natural gas leak is detected, the following safety precautions should be taken immediately.

1. Open windows and doors to ventilate the area.
2. Get everybody outside then call the natural gas company or other authorized personnel for assistance. (The telephone call should be made from outside the home. A spark from an electric switch or telephone could ignite the natural gas.)
3. Avoid flames and don't turn on or off electrical equipment or appliances. Never look for a natural gas leak with a lighted flame or match.
4. Your natural gas can be turned off at the valve next to the natural gas meter. A quarter turn of the valve in either direction will shut the natural gas off; the raised part of the valve will then be crosswise to the pipe.
5. If there is only a faint odor, it probably means a pilot light is out on an appliance. Check the pilot lights on all appliances. To relight the pilot light, follow the instructions in the owner's manual. If you still can't find the source or are unsure of how to relight the pilot light, call the local natural gas company.

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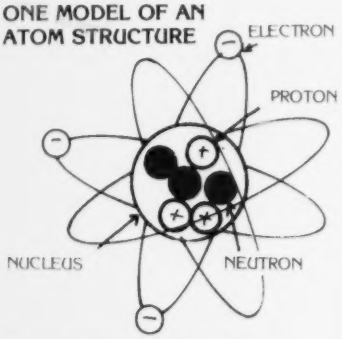
Nuclear Energy

What is nuclear energy?

Nuclear energy is derived from atoms. Atoms are particles that make up matter and are composed of neutrons, protons and electrons. The neutrons and protons are clumped together to form the center or nucleus of the atom, while the electrons orbit the nucleus.

Nuclear energy is the energy inside the nucleus of the atom which binds the nucleus together. A change in the nuclear composition of the atom results in a release of energy.

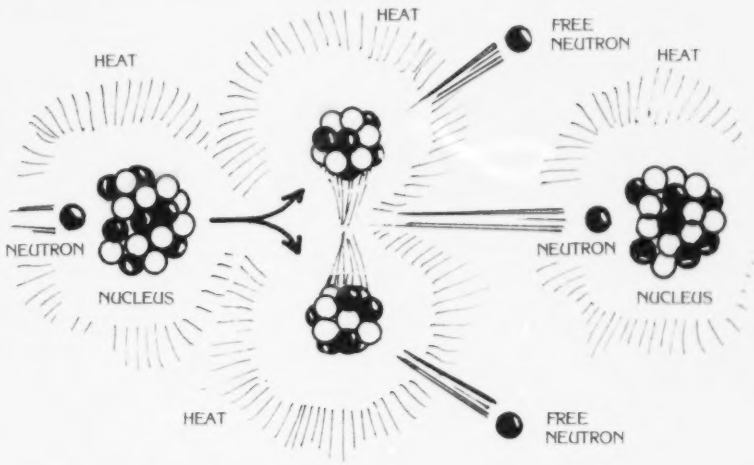
ONE MODEL OF AN ATOM STRUCTURE



How is nuclear energy released from an atom?

Nuclear energy is released from an atom through **nuclear fission** or **nuclear fusion.** In the fission process, commonly used in today's nuclear reactors, a nucleus of a target material such as uranium-235 is bombarded by a neutron which is absorbed. The absorbed neutron causes the atom's nucleus to split apart or "fission" into two atoms of lighter weight, releasing energy, neutrons and radioactivity. Fission, then is the splitting of atoms. Fission reactions produce enormous amounts of heat which turns water into steam for generating electricity. The heat is produced from the collision of fissioned particles with other atoms.

In the second process of releasing energy from the atom, the nuclei of atoms are joined through "fusion," resulting in the creation of a third element, a free neutron, and nucleus. Heat is produced when the free neutron collides with other atoms. The sun and stars get their energy from the fusion of hydrogen to produce helium. Scientists have been attempting to imitate this process for many years, but it requires extremely high temperatures. Although scientists have been unable to develop a container capable of holding such extremely hot material, one of the more promising efforts involves containing the material within a magnetic field, while it is being heated to the required temperature. The United States anticipates the eventual construction of fusion power plants.



What is a chain reaction?

When an atom undergoes fission, heat, neutrons and two lighter atoms are produced. The released neutrons are absorbed by new atoms causing them to fission, releasing more heat and more neutrons. Repeating this process over and over is a chain reaction.

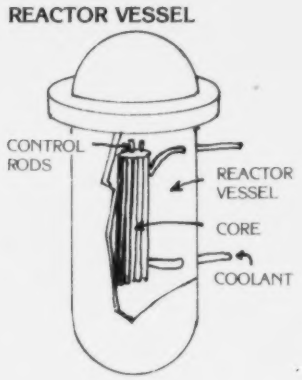
Why do we use uranium?

Uranium, which is naturally radioactive, occurs in nature as either uranium-235 or uranium-238. (The number refers to the element's atomic mass or the number of protons plus neutrons in the nucleus.) Less than 1% of naturally occurring uranium is uranium-235, with more than 99% being uranium-238. It is uranium-235 which fissions, releasing energy. Uranium-238, on the other hand, absorbs bombarding neutrons and is transformed into Plutonium-239, which fissions when struck by neutrons, releasing energy. Thus, the ability of uranium to fission or to be transformed into a fissionable element is why uranium is used in nuclear reactors.

How is fission accomplished in a nuclear reactor?

Nuclear reactors are composed of three principal parts: **reactor vessel, core** and **control rods.** The reactor vessel, a tank-like container weighing more than 500 tons with steel walls, six to nine inches thick, is located at the base of the reactor building. The core, located at the bottom of the reactor vessel, holds the fuel assemblies. Control rods are inserted into the core to regulate the rate of fission. The control rods are able to do this because of their cadmium or boron composition (materials that absorb neutrons). The absorption of neutrons controls the rate of fission. To slow the reaction, the control rods are inserted farther into the core. This decreases the number of neutrons that collide with uranium atoms, thus slow-

ing the reaction. The actual operation of the core involves the consumption of uranium-235, the subsequent creation of fission by-products and the production of plutonium. Energy released by fission is transferred to water, turning it to steam. From this point on, nuclear power plants operate just like fossil-fueled power plants.



What is spent fuel?

When the fuel assemblies can no longer efficiently sustain a fission reaction (approximately three years), they are removed from the core. The "spent fuel" as it is called, contains unused nuclear fuel and radioactive nuclear waste. The spent fuel is stored in pools of water at the nuclear power plant, until it can be reprocessed or disposed of. Water is used to cool the fuel and absorb radiation.

How do you isolate and store radioactive waste from land, water and air?

Several methods are being developed to isolate and safely store radioactive nuclear waste. One method proposed includes reprocessing the spent fuel. The used fuel would be transported to reprocessing plants where the still unused nuclear fuel would be separated from the radioactive material that needs to be safely stored.

The low-level or high-level material can be fused into a glass or ceramic solid, which is impervious to air and water, and buried in deep, stable, underground geologic formations. These storage areas would be constantly monitored.

In the future, radioactive wastes will be stored in federal repositories.

What is radiation?

Radiation is a naturally occurring phenomenon which is the result of an imbalance in the number of neutrons and protons in the nucleus of the atom. The imbalance results in an unstable atom, which emits energy or radiation. Three forms of radiation are: alpha particles, which can be stopped by a single sheet of paper; beta particles, which are stopped by a thin sheet of aluminum; and gamma rays, which are stopped by several inches of lead or about three feet of concrete. The intensity of the radiation depends on the speed at which the particle or ray travels. Thus, gamma rays are more radioactive than alpha particles as they travel at a greater speed.

What safety precautions are taken at nuclear power plants?

The Nuclear Regulatory Commission (NRC) is responsible for the regulation of nuclear power plants in the U.S. The NRC goes to great lengths to prevent nuclear accidents. The NRC requires nuclear plant operators to undergo three or more years of extensive training and examination. The NRC also administers strict construction, maintenance and safety regulations.

Nuclear power plants are monitored for radiation and are designed with safety systems which "take control" in event of an accident. Other safety features of nuclear plants are: cooling systems which pump water into the core to keep it cool; the containment building, a large dome-shaped thick-walled steel and concrete building which can prevent the escape of radiation should a problem develop; and an automatic procedure which inserts the control rods into the core to stop the chain reaction.

Because of the dilute quantities of uranium-235 used in commercial nuclear reactors, nuclear explosions are impossible. It requires at least 90% uranium-235 or plutonium-239 to produce a nuclear explosion similar to that of nuclear weapons.

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Renewable Energy Sources

Introduction

Energy is essential in our society. Energy lights and heats our homes, offices and factories. It powers the machines of industry and transportation. The clothing we wear, the food we eat, the buildings in which we live and work, and even the systems we use to communicate—all depend on energy. energy.

For generations, our society has been enjoying the benefits of plentiful, inexpensive, and easily available energy—fossil fuels. But these fuels, such as coal, oil and natural gas, are finite. As supplies have become scarce and expensive to extract, the search has intensified for alternative energy sources—sources of energy other than fossil fuels.

How is the sun an energy source?

The most obvious and virtually limitless energy source is the natural fusion reactor which the earth revolves around in space—the sun. In terms of humankind's residence on earth, the sun is an object that will last forever, continuously radiating energy that makes life on our planet possible. Although the earth intercepts only a small fraction of the total energy emitted by the sun, the amount received is thousands of times the present energy requirement of the world's human population.

The surface of the sun, which radiates energy in the form of heat and light, is called the photosphere. The sun's interior is composed of dense gases (70% hydrogen and 28% helium) and high temperatures (27 million degrees Fahrenheit/15 million degrees Celsius). The heat and light energy is produced through a thermonuclear reaction (fusion) in which hydrogen atoms are fused together to form helium.

Of the sun's energy that reaches the earth's atmosphere, 30 percent is reflected back into outer space, 47 percent is absorbed by the earth's surface and converted into heat energy, 23 percent drives the hydrological (water) cycle, less than one percent creates winds and ocean currents, and only 0.03 percent is captured by plants and used in photosynthesis. The 0.03 percent of the sun's energy captured by plants provides all the world's food energy and produced the stored fossil-fuel energy (coal, oil, natural gas). Thus, the sun is the primary source of all energy on earth.

The sun's position in the sky has a major effect on the solar energy received by the earth. In order to collect and use solar energy efficiently, one must be knowledgeable of the sun's movements, both daily and seasonally.

What is solar radiation?

Solar radiation is a form of electromagnetic radiation, just as x-rays, light waves, microwaves, television waves and radio waves. However, solar radiation differs from heat flow radiation. This difference is important to solar energy technologies.

First, color is an important factor in solar radiation, but is not in radiation heat flow. Black or dark-colored objects absorb solar radiation and become hotter, while white or light-colored objects reflect solar radiation. Color has no effect on radiation heat flow. Light- and dark-colored objects will absorb the same amount of heat energy from radiation heat flow.

The second most important difference is that solar radiation passes through transparent materials (glass, plastics), whereas radiation heat flow cannot. Thus, transparent materials trap heat energy.

How is the sun's energy harnessed?

Three primary processes exist by which solar energy can be put to practical use: photochemical, photoelectrical, and photothermal. The photochemical process, called photosynthesis, uses solar energy to unite carbon dioxide, water, and nutrients from the soil to create carbohydrates (chemical potential energy) and oxygen. The coal, oil and natural gas we use today probably resulted from photosynthesis that took place eons ago.

In the photothermal process, light energy (shortwave radiation) is transformed into heat energy (longwave radiation). As light energy strikes an object, it is either absorbed, reflected or transformed into heat energy. The heat energy is then either radiated away from the object, carried off by air or water (convection) or conducted to surrounding objects.

Photothermal technologies include: passive and active solar energy systems, power towers and Ocean Thermal Energy Conversion (OTEC) systems.

The photoelectrical process converts light energy into electrical energy. It involves the use of photons (light energy) to excite the outer (valence) electrons of atoms, causing the electrons to move, producing an electrical current. Photoelectric technologies include photovoltaics.

What is wood energy?

Chemical potential energy is produced by plants through photosynthesis and is stored as biomass. The chemical potential energy of biomass is released when the plants decay or are burned.

Wood is one of the most abundant and useful forms of biomass on this planet. Trees are a renewable resource which today cover over 30 percent of the earth's land surface. If 100 million acres of this could be used to produce wood fuel, the United States could reduce its oil consumption by 15 percent, an equivalent of 900 million barrels of oil. Even though trees take 50 to 100 years to reach maturity, we can use this valuable resource forever if we grow and harvest trees with care and planning. In our grandparents' day, wood played a major role as a fuel resource, accounting for 90 percent of the United States' energy supply. In terms of fuel use today, wood accounts for less than five

percent of the United States' energy consumption.

The most ambitious plan for the use of wood fuel is the "energy plantation." These are large tracts of land devoted to the production of trees for use in nearby electrical generating plants. It is estimated that a 1,000 megawatt plant would require between 200 and 600 square miles of woodland in order to have a sufficient supply of wood fuel.

However, there are problems with large-scale use of wood. Unless the harvesting of trees is done carefully and properly, the soil can become seriously depleted of nutrients and eroded. Also, there are simply too many of us and we want far more energy than our parents or grandparents did, so wood cannot fully satisfy our energy needs. There are also air pollution problems with burning wood in heavily populated areas.

What are biofuels?

Biofuels are derived from plants, which capture the sun's energy and convert it to biomass (chemical potential energy) through photosynthesis. Biofuels are distinguished from fossil fuels, which are also of biological origin, but are non-renewable. Biomass, in the process of being eaten, burned or decayed, transfers its energy to the rest of the living world. There are many proposals for biomass energy plantations. One idea calls for the growing of sea kelp in offshore waters of California and Peru to produce 1.8 billion tons of dry marine algae per year. This biomass would then be converted to methane, which could meet 17 percent of the current United States' natural gas demands. Some farmers are already growing crops to convert into ethanol, which when combined with gasoline makes gasohol. Gasohol is a mixture of 10 percent ethanol and 90 percent gasoline. Gasohol is one way of stretching fossil fuel supplies.

The advantages of biofuels over other fuel sources are: domestic production would have a favorable economic impact, a favorable impact on the environment (biomass is low in polluting sulfur), and the energy produced is renewable. There are, however, problems with the energy plantation concept; large land areas would be converted to single crop stands which are susceptible to disease and pest outbreaks; by centralizing energy production, the energy plantation requires elaborate electricity transmission grids.

How is refuse an energy source?

One type of biomass that has potential as an energy source is organic waste or refuse (garbage). Although still considered a problem rather than a resource, there is little doubt that refuse will be used more and more as raw materials for conversion and recycling. Refuse can also be converted to other useful forms by composting (decaying organic materials in carefully constructed piles to produce a soil conditioner and fertilizer) or anaerobic digestion (decaying organic material in airtight containers to produce methane, liquid fertilizer, or distilled to produce ethanol). However, we must remember that it takes energy to produce the items that become our refuse. Conservation — using less paper, plastics, fabrics, aluminum, etc. — saves more energy than conversion and recycling.

How is wind an energy source?

Wind is a form of kinetic energy created in part by the sun. About two percent of the sun's energy that reaches the earth is converted to wind energy. The atmosphere is heated during the day by the sun and at night it cools by losing its heat to space. Wind is the reaction of the atmosphere to the heating and cooling cycles, as well as the rotation of the earth. Heat causes low pressure areas, and the cool of the night results in high pressure areas. This process creates wind when air flows from high pressure areas into low pressure areas.

Wind energy has been used for hundreds of years. The windmills of Europe and Asia converted the kinetic energy of the wind into mechanical energy, turning wheels to grind grain. Today wind-driven generators are used to convert the kinetic energy of wind into electrical energy. Wind-driven systems consist of a tower to support the wind generator, devices regulating generator voltage, propeller and hub system, tail vane, a storage system to store electricity for use during windless days, and a converter which converts the stored direct current (DC) into alternating current (AC).

In the year 2000, wind could generate from seven to 10 percent of the total electricity produced in the United States. Farms in rural areas across the nation already find wind generators a viable energy supplement. However, the cost of a wind system that provides energy at our present rate of consumption is expensive for a single family. The most ambitious proposals to harness wind power involve the construction of wind "farms" where hundreds of wind turbines will produce electricity.

The main problem with wind energy is that it is not constant or predictable, it has a load factor of only 25 percent and is only 35 percent efficient. Many areas do not have enough wind to make generation feasible, while some locations are susceptible to gales which would destroy or damage the system. Icing can also be a problem in cooler climates. Wind systems also take up large areas and can be quite noisy. If these problems can be overcome, wind energy could be an optimum energy alternative, due to the fact that it is renewable and environmentally safe.

What is hydropower?

Hydropower is a form of solar energy. The sun's energy drives the hydrologic cycle by evaporating water from lakes and oceans and by heating air. The hot air then rises over the water carrying moisture to the land. The cycle continues when the water falls as precipitation and flows back to lakes and oceans.

The potential energy of water located at elevations above sea level is one of the "purest" forms of energy available. It can provide energy without producing pollution. It is relatively easy to control and can be converted to electricity with an efficiency of 75-85 percent. As a result, large and small rivers around the world with the appropriate topography have been dammed and waterwheels and water turbines installed to capture the kinetic energy of the falling or flowing water.

Hydroelectric installations require the construction of dams to increase the reliability of the energy available from a

stream. The dam also regulates the flow of water and creates water pressure at the bottom of the dam. The water pressure is proportional to the depth of the reservoir created by the dam. The greater the water pressure, the greater the power.

Water from the reservoir flows through the dam in pipes called penstocks to the powerhouse. In the powerhouse the water pressure is applied to a turbine which spins a generator to produce electricity. After the water has moved through the turbine, it is released into the river below the dam.

Hydroelectric power is cost-effective and proven. However, there are drawbacks. The damming of a river or stream has a critical and sometimes irreversible impact on the long-term ecological balance of that river or stream. Dams also encourage an accumulation of silt and can be a hazard in earthquake zones. However, dams create a better environment for some animals and plants, provide new recreational areas, and can control natural disasters such as floods and erosion.

How are ocean tides an energy source?

The potential energy of gravity—caused by the relationship between the earth, moon, and sun—and the kinetic energy of the earth's rotation create tides and the kinetic energy associated with their rising and falling. The key to the usefulness of tidal energy is the height difference between high and low tide.

In order to obtain energy from tides a dam must be constructed across a coastal inlet. The dam allows water to flow inwards at high tide, trapping the water. At low tide the water is allowed to flow back through the dam in a penstock. The flowing water turns a turbine and generator, producing electricity.

There are only a few locations in the United States that would be suitable for tidal energy development. In addition to the environmental concerns, there are technical and economic problems that will have to be worked out before tidal energy is feasible.

How are ocean waves an energy source?

The kinetic energy of waves is derived from the interactions of winds and ocean currents. Methods for harnessing the kinetic energy of waves are new and untested. Several different devices have been successful on a small-scale operation. All of them operated by using the natural up-and-down motion of waves. For example, the Madsuda buoy consists of an upturned canister with two holes in the top portion of the container floating in the water. As the waves rise and fall inside it, air is forced in and out by air pressure. The stream of air drives an air turbine, which, in turn, drives a generator producing electricity.

Waves, like wind, are unpredictable. Also, the environmental impact of any proposal would have to be carefully studied. Presently, wave energy is not economically feasible.

What is geothermal energy?

Geothermal energy, heat from within the earth, is the result of radioactive decay, chemical reactions, friction from the movement of crustal plates, and heat present from the earth's formation.

There are three basic forms of geothermal energy: hydrothermal, geopressurized, and hot dry rock. Hydrothermal systems are composed of hot water and steam trapped in porous or fractured rock near the earth's surface. Geopressurized reservoirs contain a mixture of hot water and methane gas trapped in sedimentary rock far beneath the earth's surface. Hot dry rock formations contain abnormally hot rock and little water.

Most of the recoverable United States geothermal reserves are located within the Western states: Alaska, California, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, and Washington.

All geothermal energy sources can be used in industrial processes and space heating, but only hydrothermal resources can be used in electrical generation. Hydrothermal resources use steam directly to turn a turbine and generator to produce electricity. In the process, steam is converted to water in a condenser and returned to the earth.

Direct application of geothermal energy to heat buildings can be found in Reykjavik, Iceland; Klamath Falls, Oregon; and Boise, Idaho. Electricity is produced by geothermal energy in only two locations in the United States: Pacific Gas and Electric Company's field at the Geysers in California, and Utah Power and Light Company's field near Milford, Utah.

Environmental and maintenance problems arise when the hot geothermal water, saturated with soluble minerals, cools and deposits the minerals in pipes and equipment. Geothermal energy, because of its localization, cannot satisfy the United States' overall energy needs.

Notes:

Electricity

Introduction

Electricity is a secondary energy source, that is, it is generated from the conversion of a primary energy source—solar, oil, coal, natural gas, or nuclear. Electricity is unique, as it is energy in transit, kinetic energy, obtained when electric charges are set in motion by an electromotive force.

But to most people, electricity is the cause of lightning, or the form of energy that powers their television set and lights their home. They have a limited understanding of the scientific principles and technologies required to generate, transmit, use, and manage electricity.

What is the atomic structure of matter?

Since the time of the ancient Greeks, matter has been thought to be made up of atoms ("atom" is the Greek word for "indivisible"), though the Greek ideas about the nature of these "indivisible" particles were rather vague. Through the work of Niels Bohr, Lord Rutherford and others it was revealed that atoms actually have a complex structure.

According to Bohr's theory, an atom consists of a positively charged nucleus, surrounded by negatively charged particles, called electrons. The nucleus of an atom consists of two fundamental particles: protons and neutrons. The proton carries a positive charge while the neutron has no charge.

The positive charge of a proton is equal to the negative charge of an electron. Since atoms ordinarily are electrically neutral, the number of positive charges equals the number of negative charges — that is, the number of protons in the nucleus is equal to the number of electrons surrounding the nucleus.

What are ions and ionization?

An ion is an atom that has become electrically unbalanced by the loss or gain of one or more electrons. When an atom loses an electron, its remaining electrons no longer balance the positive charge of the nucleus, and the atom acquires a positive charge. This atom is called a cation. Similarly, when an atom gains an electron, it acquires a negative charge and is called an anion. The process of producing ions is called ionization.

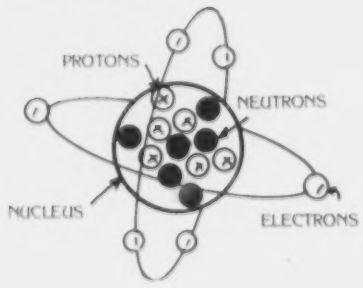
Ionization does not alter the chemical properties of an atom, but it does produce an electrical charge. Ionization can be brought about by the collision of electrons or by exposure to radiation. This is because the electrons in the outermost shell of an atom are held rather loosely and, hence, can be dislodged easily.

What are free electrons, conductors and insulators?

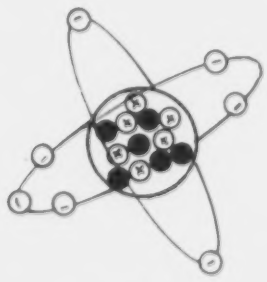
Electrons that have been "knocked" out of the outer shell of an atom are known as "free" electrons. These free electrons can exist by themselves outside of the atom, and it is these electrons which are responsible for most electrical phenomena. The movement of free electrons constitutes an electric current.

All substances normally contain free electrons that are capable of moving from atom to atom. Metallic materials, such as silver, copper, or aluminum, contain numerous free electrons capable of carrying an electric current and are called conductors. Non-metallic materials, which contain few free electrons, are called insulators. Materials that have an intermediate number of free electrons available are classed as semiconductors. The more free electrons a material contains, the better it will conduct electricity.

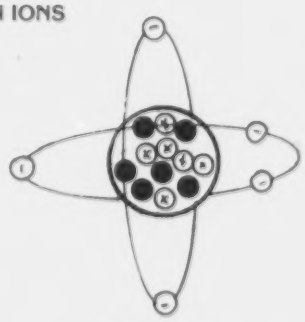
A CARBON ATOM



CARBON IONS



NEGATIVE ION
(ANION)



POSITIVE ION
(CATION)

What is electric current?

The free electrons in a conductor are ordinarily in a state of chaotic motion. However, when an electromotive force (or voltage) is applied, such as that provided by a battery or electric power plant generator, the free electrons in the conductor are guided in an orderly fashion, atom to atom. This orderly motion of free electrons under the influence of an electromotive force is called an electric current. Although electrons drift through the wire at a relatively slow speed, the disturbance or impulse is transmitted almost at the speed of light. The electron current continues to flow through the conductor as long as the electromotive force is applied. The conductor itself remains electrically neutral, since electrons are neither gained nor lost by the atoms within the conductor. What happens is electrons enter the conductor from one end and an equal number of electrons are given up by the other end of the conductor. Thus, the free electrons present within the conductor act simply as current carriers.

Electric current is the transport of electric charge (electrons). Electric current is measured in amperes and is the amount of electrons passing a given point in one second. An ampere is equal to about 6.25×10^{18} electrons per second.

Voltage on the other hand is a measure of potential difference, the electromotive force necessary to move electrons through conductors. The amount of electric current moved through a conductor by the voltage is influenced by the conductor's resistance.

Electric power, the rate at which work is performed by moving electrons (electric current), is measured in watts and is determined by multiplying the current by the voltage:

1 watt = 1 amp x 1 volt

Because of the relationship between electric current and voltage to perform work, the same amount of work can be performed with either a high current and low voltage or a low current and high voltage.

What is resistance?

The opposition to the flow of free electrons in a material is called resistance. The resistance of material dissipates energy in the the form of heat, because of friction between the free electrons and atoms of the material. As the material is heated, more collisions occur and the resistance to the flow of electric current increases.

The resistance of electrical conductors depends on their dimension and on their composition. As the cross-sectional area increases, the resistance decreases; but as the length increases, the resistance rises. A long, thin conductor, therefore, has more resistance than a short, thick one with the same volume of material. Silver has less resistance than copper, whereas aluminum and iron have more.

Although the same voltage may be applied to a light bulb and an electric iron, the actual current flow is different in each, because each has a different resistance. So not only does the voltage determine how much current flows through an electrical appliance but also the resistance of the appliance. The relationship between resistance (R), voltage (V), and current (i) then, can be expressed by the mathematical formula: $i = V/R$. The unit of measure for resistance is the Ohm, which is named after George Ohm who was the first person to specify the relationship between resistance, voltage, and current. It is this resistant property of conductors which is used to produce light or heat from electricity.

What is static electricity?

When certain materials are rubbed together, free electrons are transferred by friction from one to the other, and both materials become electrically charged. These charges are not in motion but reside statically on each material, and hence this type of electricity is known as static electricity. We've all had experience with static electricity: lightning during a storm; sparks flying after we shuffle over a rug; hair standing up on end after brushing — all these are typical examples of the effects of static electricity. This type of electricity is produced by friction.

What is thermoelectricity?

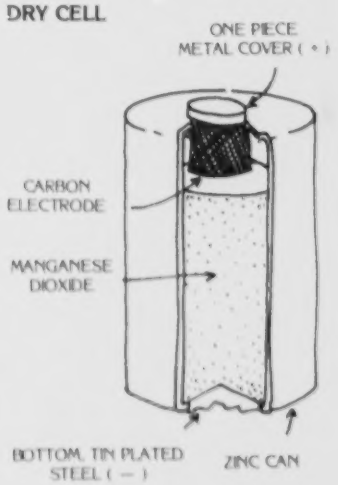
When two dissimilar metals, such as a copper and iron wire, are joined together at both ends, the free electrons will pass haphazardly in both directions across the junction. Because of the different atomic structure of the metals, electrons pass more readily in one direction than in the other. This results in a displacement of charges, making one metal positive and leaving the other negative. By keeping one junction at a higher temperature than the other, a thermal electromotive force is obtained, and an electric current is produced.

A single junction of two different metals that are twisted, brazed or riveted together at one end, is called a thermocouple.Thermocouples are not used to produce electric current, since the effect is small. Their chief use is for measuring temperatures and currents in electrical appliances and furnaces.

What is electrochemistry?

In 1795, the Italian physicist Alessandro Volta made the first electrical cell by placing two dissimilar metal electrodes in a conducting chemical solution, called an electrolyte. An electromotive force is produced in such a cell by the separation of charge, brought about by the chemical reaction between the elec-

DRY CELL

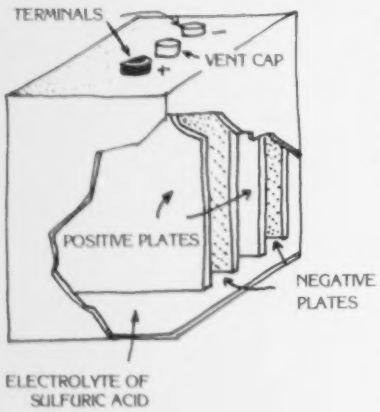


trodes and the electrolyte. This arrangement is known as a voltaic cell after its inventor. The electromotive force generated by a voltaic cell depends on the tendency of the electrodes' atoms to lose electrons and thus form positive ions.

The voltaic cell most widely used as a convenient source of "portable" electricity is the "dry cell," or common flashlight battery. A typical dry cell consists of a zinc metal housing, which acts as the negative electrode, and a carbon rod in the center, acting as the positive electrode. The electrolyte is a chemical paste consisting of ammonium chloride mixed with manganese dioxide. The manganese dioxide absorbs hydrogen produced from the chemical reaction. In operation, the metallic zinc delivers positive zinc ions to the electrolyte, causing a difference in charge between the zinc and carbon electrodes. If the zinc and carbon electrodes are connected in a circuit, electrons will flow from the zinc electrode to the carbon electrode, producing an electric current of about 1.5 volts. Since the electric current produced by a battery flows only in one direction, it is called direct current (DC).

Secondary cells, also called lead storage batteries, deliver current by chemical reaction like voltaic cells. However, the chemical reaction in a secondary cell is reversible, permitting it to be restored to its original condition. To restore or recharge a secondary cell, all you have to do is pass an electric current through it in a direction opposite to that of its normal use or discharge. The lead storage batteries in automobiles are secondary cells.

LEAD STORAGE BATTERY



What are magnetism and electricity?

Magnetism and electricity are not two separate phenomena. In fact, whenever an electric current flows, a magnetic field is created, and whenever a magnet moves, an electric current is produced. The properties of magnetism and electricity are both bound up in the nature of the physical structure and arrangement of atoms and their electrons. Materials that appear to be magnetic, without any outside source of electricity, depend on electron movement within their atomic structure to provide the electric current.

Electromagnetism is the effect by which electrical currents produce magnetic fields. The magnetic field around a straight wire is weak. Stronger magnetic fields are obtained by coiling wire into a spiraling loop, known as a solenoid. The effect of forming a solenoid is to increase the intensity of the magnetic field without having to increase the current. An iron-cored solenoid has a stronger magnetic field than that of an air-cored solenoid. This is because the electrons in the iron align themselves with the magnetic field produced by the current. Iron-cored solenoids are called electromagnets. Electromagnets energize the fields of motors and generators, and are part of telephones, loudspeakers, buzzers, electric bells, telegraphs, relays, electric meters and many other devices.

To produce an electric current from a magnet, the magnet must rotate inside a loop of wire or the wire loop must rotate between two magnets. The magnet creates an electromotive force, which causes the electrons in the wire to move, inducing an electric current. The rotation of the magnet or wire loop alternates between "pushing" and "pulling" the electrons, due to the magnet's polarity. The electric current produced thus alternates its direction of flow, and is therefore called alternating current (AC). Alternating current changes direction 60 times a second in the United States.

How do motors and generators work?

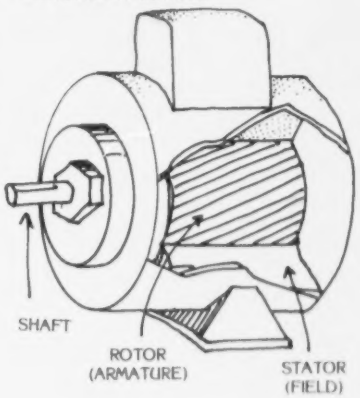
Motors and generators are basically the same in construction, although their functions are opposite. Motors are supplied with electrical energy to provide mechanical energy; generators are supplied with mechanical energy to produce electrical energy.

The two most essential elements of each of these machines are field and the armature. The field is a magnetic field which may be derived from permanent magnets or electromagnets.

The armature is a conductor arranged to pass through the field's magnetic lines of flux at right angles. The armature conductors may be wound onto a cylinder that rotates in the field, or they may be fixed to the inner walls of a cylinder, within which the field windings rotate. The armature is generally wound on a soft iron core to produce maximum flux for a given current. The soft iron is laminated (made up of thin slices) to prevent the electric current from circulating in the iron itself, and thus generating heat. The static part of the machine is called the stator and the revolving part the rotor. Both the field and the armature may be on either the stator or the rotor.

The armature must be supplied with electrical current if it is the rotor of a motor, and there must be a way of taking the electric current from it if it is a generator.

ELECTRIC MOTOR



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What is a transformer?

One of the most essential electrical devices is the transformer. It is used in power stations and at substations — in the former to boost voltages for transmission over power lines and in the latter to reduce voltages to levels suitable for industrial or domestic use. Transformers contain two separate wire coils wrapped around an iron core. Electricity flows into the transformer through the first coil. As the electricity flows through the first coil, it produces a magnetic field in the iron core. The magnetic field then induces an electric current in the second coil which flows out of the transformer. Oil is circulated around the coils and iron core to insulate and cool the transformer. If the voltage is to be increased, the second coil contains more turns of the wire than the first coil. If the voltage is to be decreased, the second coil contains fewer turns of the wire than the first coil. Transformers are also used in many electrical appliances — such as radios, televisions and battery chargers — wherever voltage different from the supply is required.

How does the light bulb work?

The incandescent light bulb consists of a thin resistive tungsten filament, attached to a metal screw-type base. The filament is mounted inside a glass bulb, which is filled with an inert gas—either argon or nitrogen. The inert gas prevents the rapid burning of the filament. The resistance causes the filament to be heated to incandescence, producing light.

Fluorescent light bulbs contain filament electrodes at each end of the tube. The tube wall is coated with phosphor (a material that fluoresces under ultra-violet radiation) and is filled with mercury vapors. Electricity flows through the filament, causing the filament to emit electrons. The electrons cause the mercury vapor to break down and discharge ultra-violet radiation, which causes the phosphor to fluoresce, producing light.

Fluorescent lights are more efficient than incandescent lights. A 40-watt fluorescent light bulb will produce the same amount of lumens (light) as a 150-watt incandescent light bulb.

How does a circuit work?

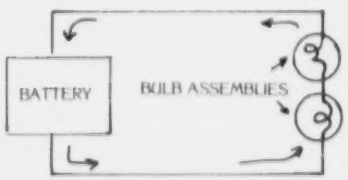
An electric circuit is the system by which an electric current is directed, controlled, switched on, or switched off. Circuits can contain from two or three to many hundred different components, according to the way in which the current is to be controlled.

The primary requirement of a circuit is that it form a complete path; electrons must be able to flow through the whole system so that as many electrons pass back into the source of the current as leave it.

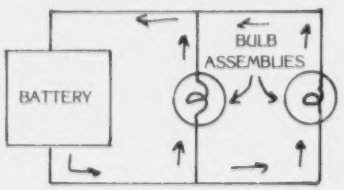
If the electricity is able to flow completely through the circuit, the circuit is said to be a "closed-circuit." If the electricity is unable to flow completely through the circuit, the circuit is said to be an "open-circuit."

There are two basic circuits in which electricity flows — series or parallel circuits. In a series circuit all of the electrical components are connected to each other in a "series," thus, the electric current has only one path to follow and flows through each component. In parallel circuits, the electrical components are connected individually to the main electrical circuit; thus, the electric current has more than one path to follow. Parallel circuits allow for individual control of each electrical component. Buildings, most appliances, motors, etc., are wired in parallel circuits.

SERIES CIRCUIT



PARALLEL CIRCUIT



How is electricity distributed in the home?

Electricity is brought to a house through a three-wire cable and connected via an electric meter, which indicates power consumption to the household circuit breaker or fuse box. The two "live wires" are then brought from the fuse box to power outlets (plug-ins), utility boxes (lighting), and wall switches. Each of the two live wires is at a voltage of 120 volts relative to ground and 240 volts relative to each other. The third wire, or neutral, is brought to a grounding bar in the circuit breaker box, or attached to a metal cold water pipe, as well as to all power outlets, utility boxes, and wall switches. Every appliance that is plugged into an outlet also has a ground connection. The appliance ground is connected to the metal or plastic case of the appliance.

If the two live wires should inadvertently come in contact with each other or the ground, a "short circuit" occurs which can result in a fire. In a properly wired house, such a short circuit causes a fuse to melt or a breaker to open, thus breaking or opening the circuit preventing electricity from flowing to that portion of the house or appliance and causing damage.

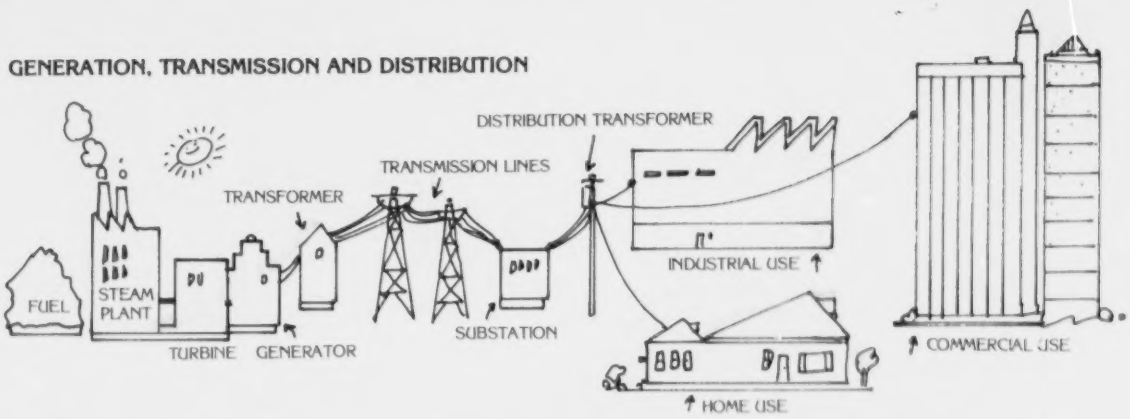
Fuses contain a metal alloy strip that melts when overloaded. Circuit breakers are essentially heat- or current-activated switches that open when overloaded.

At each power and lighting outlet no current flows until a lamp or appliance is plugged in and switched on. However, there is always a voltage at that point whether current flows or not. It is like a water tap; the pressure is always there although there is no flow until it is turned on.

How is electricity generated, transmitted and distributed?

Heat produced by the combustion of fossil fuels (coal, oil or natural gas) or the fission of uranium is used to convert water to steam. The steam is then piped to a turbine where it strikes the turbine blades, causing the turbine shaft to rotate. The rotating turbine shaft is connected to the generator's wire coil. As the turbine shaft rotates, it causes the generator's wire coil to spin. The spinning wire coil is surrounded by

GENERATION, TRANSMISSION AND DISTRIBUTION



magnets, which induce an electric current in the wire coil. The generator produces an electric current of about 22,000 volts. The electric current flows from the generator to the power plant transformer where the voltage is increased or stepped up.

The voltage is increased to reduce transmission loss. Transmission loss is due to the resistance of the transmission line to the flow of the electric current. The resistance produces heat. As the electric current increases, so does resistance and thus transmission loss. Since the same power can be obtained by transmitting electricity either at high current and low voltage or high voltage and low current, it is more efficient to transmit electricity at high voltage and low current, as less electricity is converted to heat through transmission line resistance. However, at high voltages the air surrounding the transmission line becomes partially ionized and some electricity is lost through atmospheric discharge. The distance the electricity needs to be transmitted determines how much the voltage is increased; the voltage can be stepped up as high as 765,000 volts. A 765,000-volt transmission line transports about as much electricity as five 345,000-volt transmission lines, due to transmission loss of the lower voltage system. From the power plant transformer, the electricity is transmitted throughout the electric utilities' service area through high power transmission lines. The utility's transmission lines are also connected with other electric utilities' transmission lines forming a power pool. The transmission lines transport the electricity to the electric utility's local substations. Substation transformers decrease or step down the voltage to between 5,000 and 35,000 volts (12,000 volts is the most common). Wooden power-pole distribution lines carry the electricity from the substation to consumers. However, before the electricity is used by the consumer, its voltage is stepped down by the power-pole transformer. The voltage is stepped down to either 120 or 240 volts.

What is energy conservation?

Electricity, while one of the most convenient forms of energy, is also one of the most inefficient. Steam turbine efficiencies have risen from 5 percent early in this century to about 35 percent today, but this still means that 65 percent of the coal or oil burned in power plants is lost as waste heat and pollution. The generating efficiency of an electrical network, including losses in transmission, is about 25 percent. A further small loss occurs when electricity is converted into heat, light, or mechanical energy of appliances, producing an overall efficiency of about 22 percent. However, electricity can do things that other energy sources cannot. It can drive a whole variety of household machines, power record players and television sets, and provide instant, clean and effective lighting.

Since much of our electricity must be produced through the use of the earth's supply of fossil fuels, conservation is important. Residential appliances consume roughly one-third of the electricity produced in the United States. Refrigerators alone utilize the electrical output of about 25 large power plants, nearly seven percent of the nation's consumption. Improving the energy efficiency of appliances is, therefore, an important step toward conserving fuel resources.

When buying home appliances it is important to check the energy efficiency rating and purchase the right size appliance. Oversized appliances consume more electricity and undersized appliances will have to work harder and thus, consume more electricity. Always compare the wattage of appliances (wattage will inform you how much electricity the appliance will consume). Also be sure to turn off lights and other electrical appliances when you are not using them.

Is electricity safe?

Electricity, when used properly, is a safe and convenient form of energy, but when used improperly, electricity can cause fires, shocks, injuries, and even death. The following safety tips will help you avoid electrical accidents.

- Be careful with electrical cords: don't place cords where people will trip over them or where they will receive excessive wear; keep cords away from heat and water; don't pull on cords to disconnect them, pull on the plug; and don't twist, kink or crush cords.
- Never use an appliance while standing in water or when wet.
- Don't touch metal plumbing or metal objects and appliances at the same time.
- Keep combustible materials away from lamps or heating devices.
- Disconnect appliances before cleaning.
- Keep ladders away from electric power lines.
- Turn off circuits when changing light bulbs.
- In case of an electrical fire, call the fire department; unplug appliance if safe; use fire extinguisher or baking soda, never use water.

- Never touch broken electric lines. Call police and the electric company immediately.
- In case of electric shock, do not touch victim until electricity is turned off. If victim is in contact with electric power lines, the only safe procedure is to call the power company. If victim is in contact with low voltage cord, use a dry rope or stick to remove victim. Call hospital and, if necessary, give artificial respiration or, for shock, cover victim and raise his/her feet.
- Never attempt to remove a kite from electric power lines, and be aware of the location of electric power lines when flying kites.
- When climbing trees, be sure that electric power lines don't touch the tree; if so don't climb the tree.

Notes: _____

Food: The Fuel That Keeps You Going

Introduction

Everyone knows that the real reason to eat isn't simply for pleasure. Eating is what provides our bodies with the energy to live. The attractive colors, aromas, flavors and textures of favorite foods aren't really important to the solid necessity of eating for survival. They do play a role, however, since they provide variety and make eating a lot more enjoyable.

Where does energy in food come from?

The food chain for humans begins with plants. Under ordinary growing conditions, plants require soil, water, air and sunlight. Of these elements, the energy source is sunlight, or solar energy, which is used by the plant leaves to combine chemicals from air and water.

Carbon dioxide from air and hydrogen from water are combined to form carbohydrates. These carbohydrates, stored in the plant's leaves, stems and roots, are the major energy source for the animals (including humans) who eat them.

Plants get their food from the soil which supplies chemicals for making proteins, vitamins and minerals.

When we, in turn, eat plants, our bodies use these proteins, vitamins and minerals as building materials for bones, muscles and all the rest of our physical parts.

It's the carbohydrates, though, that we use for energy. Our bodies break down the carbohydrates into three fuels. **Glucose** is the fuel we use for a constant level of energy. **Glycogen** provides an extra-rich fuel for sudden emergencies. And **fat** is a long-term storage fuel.

All three fuels are necessary to provide the heat that keeps our bodies operating at a constant temperature of 98.6° F (37° C). These fuels also provide the energy for your heartbeat, breathing, walking, talking and other physiological functions.

When we eat beef, fish, poultry and other meats, we are really eating plants that have been converted to another form. The energy is still there.

How is energy used to make food and deliver it to us?

The days are long gone when most people grew their own food and survived independently. Today, much of what we eat comes from other people and places and is the result of a complex series of events.

A good example of a staple crop is corn.

Corn requires many chemicals from the soil, so farmers must keep fertilizing the soil to replace important chemicals. Usually, fertilizers made from natural gas are used.

Farm machinery, of course, burns gasoline or diesel fuel to do the plowing and planting. If rainfall is poor, farmers may need to irrigate, which requires electricity to run the irrigation pumps. Pesticides made from petroleum keep the corn healthy.

Then, fuel-burning machinery picks the corn which is transported by truck or rail to where it is sold. Since this may be thousands of miles away, the fuel (and energy used) is often substantial.

Once the corn gets to you, other forms of energy may be necessary to husk it, clean it and cook it to your tastes.

Meanwhile, energy is being used to produce and ship many other types of foods which will eventually end up on your table.

And the entire process has only one purpose: to give you energy to survive.

(Adapted from **Energy Readings**, part of the New York Energy Education Project, with permission of the New York Power Pool.)

Notes: _____

Energy Lessons

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INDEX TO ENERGY LESSONS

Lesson	Grade Level	Goal Area	Subject Matter Emphasis				
			Science	Math	Social Studies	Art	Language Arts
1. Stuffed Suns	K-3	Sources	X			X	
2. Energy Source Coloring Book	K-3	Sources	X			X	X
3. Let's Learn About Energy Sources	2-3	Sources	X			X	
4. Where Does It Get Its Energy?	K-3	Uses	X			X	X
5. Energy Talk	2-3	Uses	X			X	
6. Energy Trip Ticket Game	K-3	Uses	X		X	X	
7. Do Electrical Appliances Save Time?	2-3	Uses	X	X		X	X
8. Electrical Safety Tips From Power Bear	K-3	Uses	X			X	X
9. Energy, Work and Movement	K-3	Conversions	X				
10. A Bright Idea	2-3	Conversions	X				
11. Food Chains	2-3	Conversions	X			X	
12. Energy For Electricity	K-3	Conversions	X				
13. Energy To Grow On	K-3	Conversions	X				
14. Food, Energy and You	2-3	Conversions	X	X			X
15. Electricity: Who Needs It?	2-3	Conversions	X		X		
16. Energy At Work	K-3	Impacts	X			X	
17. Burning Releases Energy & Waste!	2-3	Impacts	X				
18. Coal: More Than Meets The Eye!	2-3	Limits	X	X			
19. How Long Will It Last?	2-3	Limits	X				
20. Now You're Cooking!	2-3	Limits	X				
21. Pass The Sack	2-3	Limits	X		X		
22. Astronaut Energy	2-3	Future	X	X	X		
23. Turn On To Switching Off!	K-1	Conservation	X			X	
24. Save Or Waste?	2-3	Conservation	X				X
25. Save Energy With Power Bear	K-3	Conservation	X			X	X
26. Be An Energy Saver!	2-3	Conservation	X				
27. Keep It Cool!	2-3	Conservation	X				
28. The Best Color	2-3	Conservation	X	X		X	
29. Eagle Eye, The Energy Waste Spotter	K-1	Conservation	X				
30. Helping Hands	2-3	Conservation	X			X	X
31. Create A Commercial	2-3	Conservation	X			X	X

Stuffed Suns

Activity 1

Science, Art	Sources	Grades K-3	Time 45 min.

Concept

The sun is the primary source of the earth's energy.

Activity Goal

The students will identify several ways that the sun's energy comes to us.

What You'll Need

- 18 x 36-inch pieces of butcher paper or newsprint
- Color crayons or poster paint, markers
- Staples and stapler
- Old newspaper
- String

What To Do

1. Discuss with students the sources of energy that get their energy directly or indirectly from the sun. Examples include: coal, oil, water power, wind, natural gas, food, wood, gasoline. Explain that fossil fuels (coal, oil, natural gas) come from plants and animals that have been buried for millions of years. The weight from the layers of mud and sand created pressure and heat that changed the plants and animals into fossil fuels.

2. Help the students trace the energy sources mentioned in step one back to the sun.

3. Have the students make stuffed suns.

A. Give each student an 18 x 36-inch piece of butcher paper or newsprint. (Smaller suns can be constructed.)

B. Instruct students to fold paper in half and to paint or color a large sun on either side of the fold. Encourage creativity!

C. On the rays, print some of the different ways we get energy from the sun using the discussion from step one.

D. Staple across top and one side.

E. Stuff with old newspapers and complete stapling.

F. Decorate the room with stuffed suns by taping string to sun and hanging from the ceiling.

Evaluation Idea

Have the students list sources of energy that get their energy from the sun.

Notes: _____

Sources of Energy Coloring Book

Activity 2

Science, Art, Language Arts	Sources	Grades K-3	Time 8×30 min.

Concept

Energy sources can be classified in many different ways.

Activity Goal

The students will identify and describe at least four sources of energy.

What You'll Need

- Copy of coloring book for each student
- Crayons

What To Do

1. Each day, introduce a new source of energy from the coloring book. Read the story.
2. Introduce the source, how it is used, and how it is formed in addition to what the story tells.
3. Have students color the picture.

Career Awareness Ideas

1. Describe careers involved directly and indirectly with each source.
2. Invite any parents who work with any of the sources to speak to the class about their professions.

Evaluation Idea

Have the students identify and draw several energy sources.

Notes:

Sources of Energy Coloring Book

Energy from Food
Food gets its energy from the Sun!
Our bodies need food energy to stay healthy and active!
POWER BEAR
Milk
Cereal
Bread
40

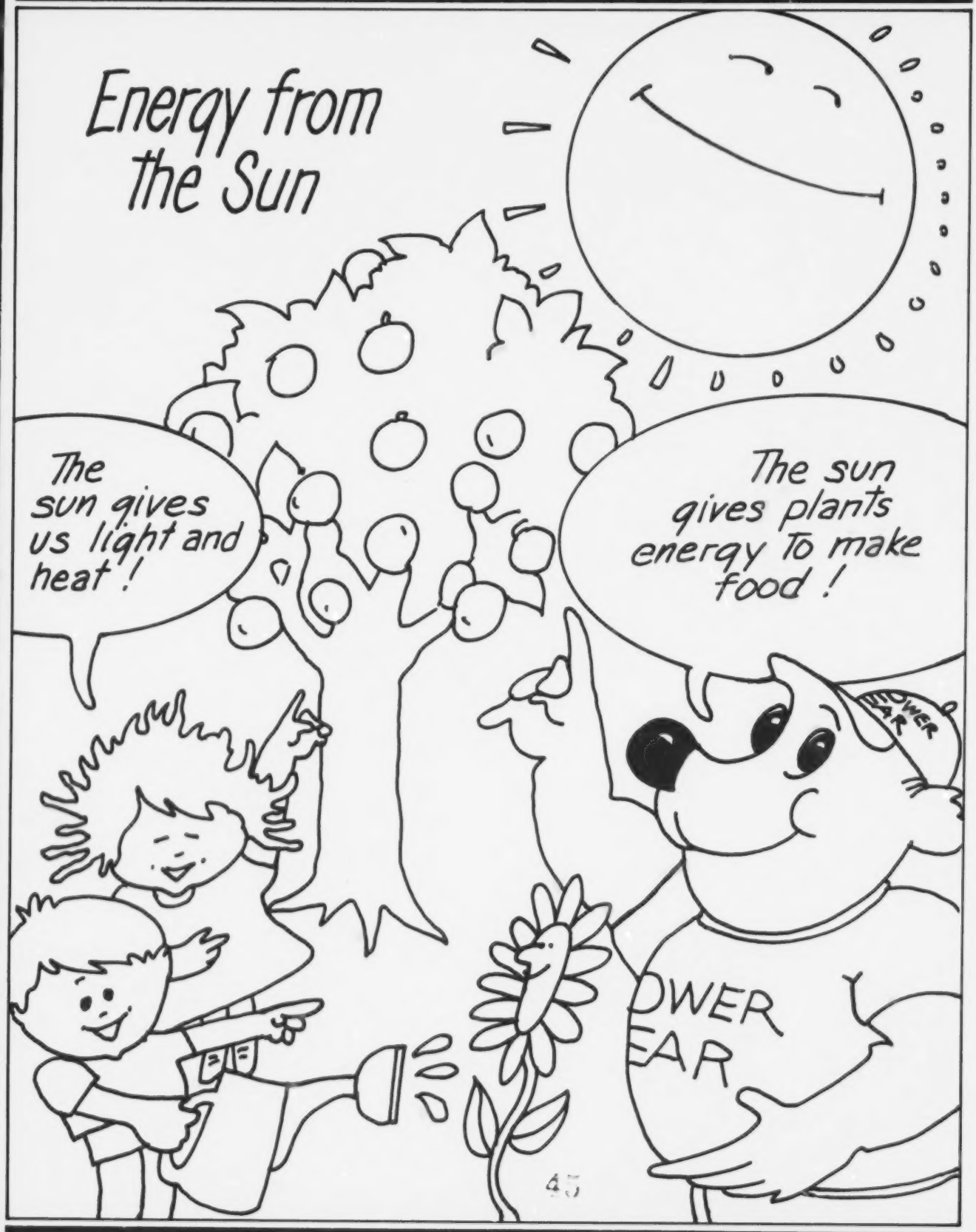
Energy from the Wind
Wind is energy we can use!
Wind makes sailboats go.
Wind turns windmills.
Wind gets its energy from the sun!
POWER BEAR
POWER BEAR

Energy from Oil
Oil got its energy from the sun!
Oil is burned to make heat and to keep us warm.
Oil is used to make gasoline for our buses, cars and trucks.
POWER BEAR
School Bus
42

Energy from Wood

43

Energy from Moving Water
The energy of moving water can be used to make electricity!
POW BEA
POW BEA
44


Energy from the Sun
The sun gives us light and heat!
The sun gives plants energy to make food!
OWER
EAR
OWER
EAR

Energy from Natural Gas
Natural Gas is burned to make heat for cooking food and for keeping us warm.
A long time ago natural gas got its energy from the sun.
46

Energy from Coal
Heat from burning coal is used to make electricity at power plants. In factories coal is used to make metal.
POWER BEAR
We burn coal to get its energy.

Coal is found underground. The coal we burn today was formed by plants that lived millions of years ago.

Let's Learn About Energy Sources!

Activity 3

Science, Art	Sources	Grades 2-3	Time 2×45 min.

Concept

Energy sources can be classified in many different ways.

Activity Goal

The students will identify at least four energy sources through sensory experiences.

What You'll Need

- Coal (Charcoal)
- Oil
- Water
- Wood
- Food
- Electrical appliances
- Drawing paper
- Magazines
- Barbecue Grill
- Pinwheel
- Fan
- Plants
- Felt tip markers
- Art supplies
- Kerosene lamp or camping lantern
- Containers to hold fuel sources
- Set of Energy Source flashcards for each student

What To Do

1. Tell the students that they will explore some things that supply us with energy. Ask "Why do we need energy?" List their responses on chalkboard.

2. Have students observe and talk about various energy sources, using the appropriate senses of touch, smell and sight. Have samples of the following energy sources readily available.

Coal
Oil (can)
Falling water (faucet)
Wood
Food (apple)
Wind (fan, outdoor wind)

Discuss the energy sources. Explain that they are samples of things people use as sources of power to run machines, heat buildings and to provide food.

3. Demonstrate that energy may be released from various energy sources. Ask the students to make observations. Remind the students that the energy released will take the form of heat, light, sound, electricity or movement.

A. **Coal.** Set up a barbecue or hibachi outdoors if possible, ignite the coal, and when it is burning, have students observe its appearance.

B. **Oil.** If your school has an oil furnace, ask the custodian to take the children on a tour of the furnace room. Some students may also live in homes heated by oil furnaces and might make limited observations under parental supervision.

C. **Kerosene.** Bring a camping lantern or lamp to class and show how it works. Observe forms in which energy is released.

D. **Sunlight.**
(1) Introduce the term "solar energy" and how people can use it.

(2) Grow plants in containers; put several in a dark place for at least a week (watering as needed). Keep the rest in good lighting conditions. After sprouting, compare the two sets of plants. Discuss the need of plants for light energy.

E. **Food** (nutrition). After eating lunch, point out that food gives us energy to be active. Without adequate food we would be less active and eventually may become weak or sick.

F. **Wind.** Using a fan or the wind, observe the turning of a pinwheel. Relate that in this case moving air is the energy source—one also used to move a sailboat.

G. **Wood.** Using a barbecue grill, burn some wood. Discuss the energy released from the wood. What happens to the wood? What wastes are created? (ash, smoke) Explain that any time a fuel is burned, wastes are created.

H. **Electricity.** Using a wall outlet, demonstrate to students the heat released from an iron or hot plate, light from light bulbs, and the motion of beater in a food (hand) mixer. Use a flashlight or a toy to demonstrate energy from batteries. Inform students that electricity is a form of energy.

4. Reproduce and cut energy source flashcards. Have students color the energy source flashcards. Suggest a series of activities and have students hold up the energy source flashcard that shows the kind of energy needed for the activity. (Example: flowers growing—sun energy)

Evaluation Idea

Use the energy source flashcards to have students identify ways each source can be used.

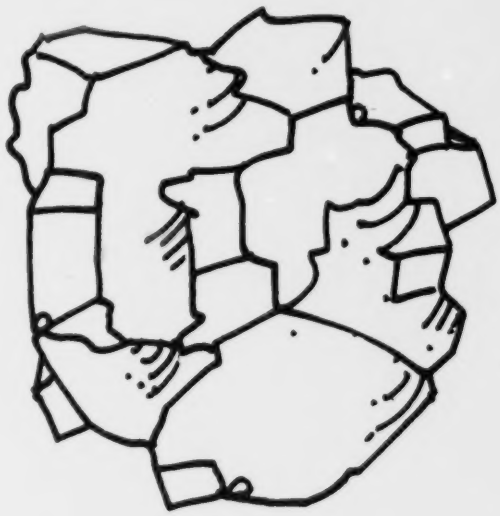
Notes: _____

Energy Source Flashcards

Name _____

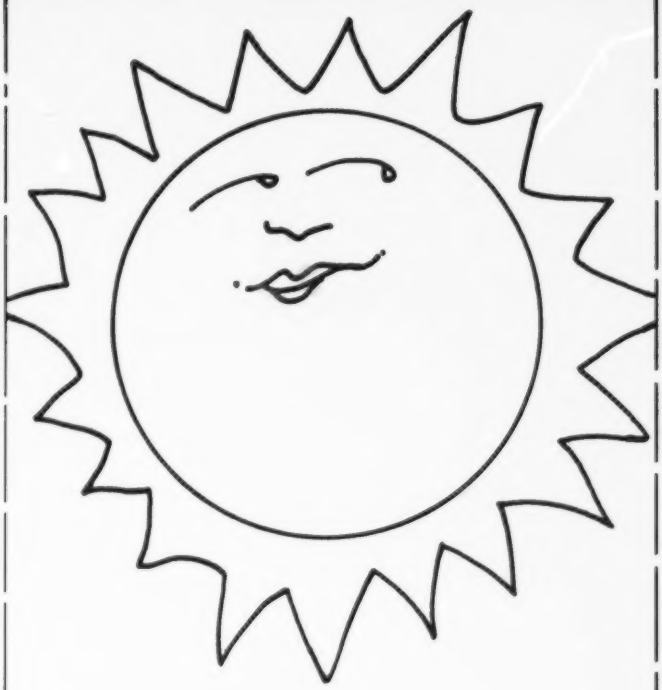
Date _____

Wind

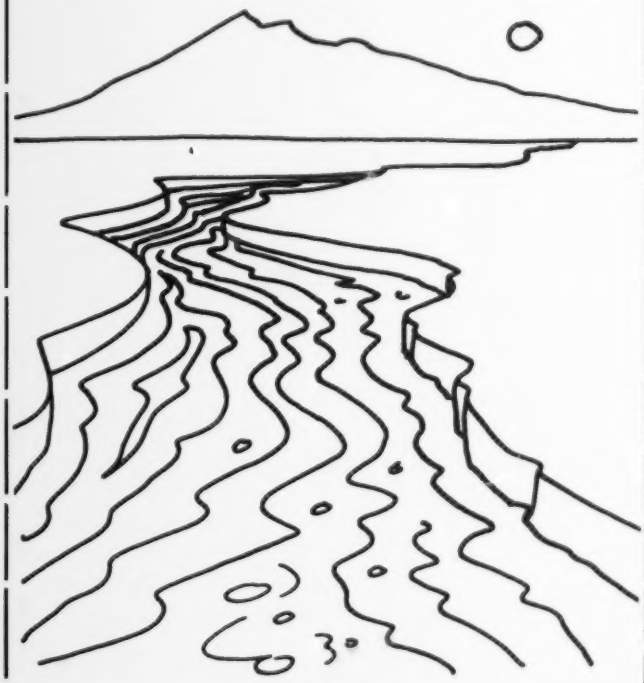


Coal

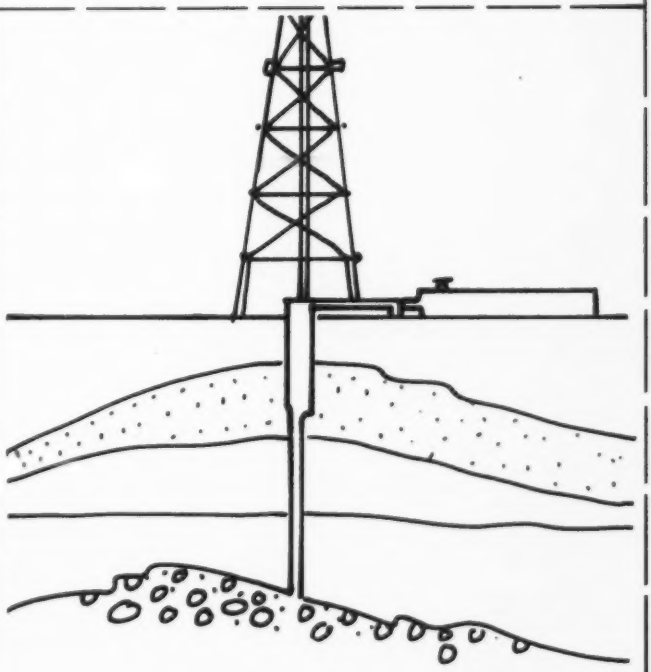
Food



Sun



Moving Water



Natural Gas

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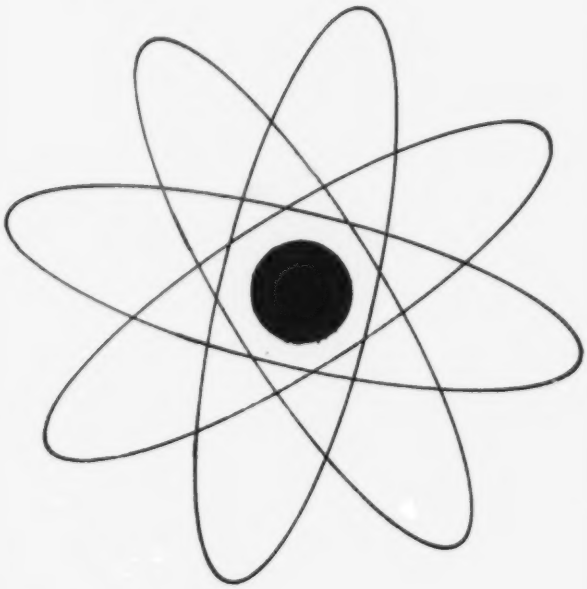
Wood

Oil



Nuclear

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Where Does It Get Its Energy?

Activity 4

Science, Art, Language Arts	Uses	Grades K-3	Time 45 min.

Concept

All living things and natural processes require energy.

Activity Goal

The students will match energy words to energy use pictures.

What You'll Need

- Crayons
- "Where Does It Get Its Energy" worksheet - one copy for each student

What To Do

1. Write the following energy words on the chalkboard and go over each word with the students. Also ask students to suggest ways that the energy can be used.

Gasoline
Sun
Wood
Wind
Food
Electricity
Coal
Natural Gas

2. Duplicate the cut-and-paste word-picture sheet. Have students color the energy use pictures.

3. Have students cut and paste the energy words to the correct pictures.

4. Discuss the students' answers.

Evaluation Idea

Write the energy words on the chalkboard and go over them with students. Have each student illustrate how one of the energy words is used.

Notes:

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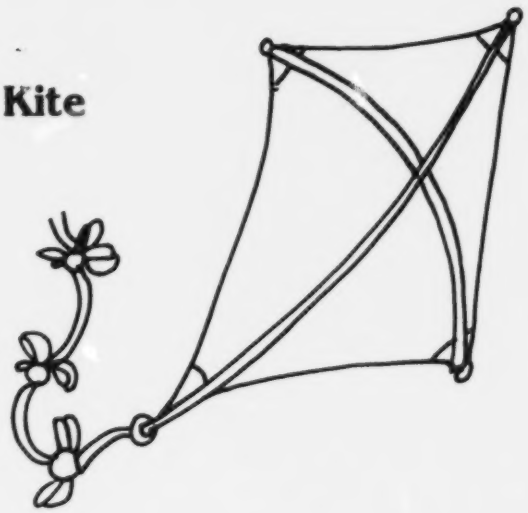
Where Does It Get Its Energy?

Name _____

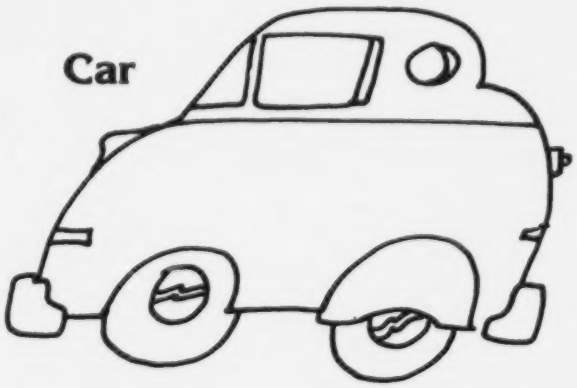
Date _____

Kite

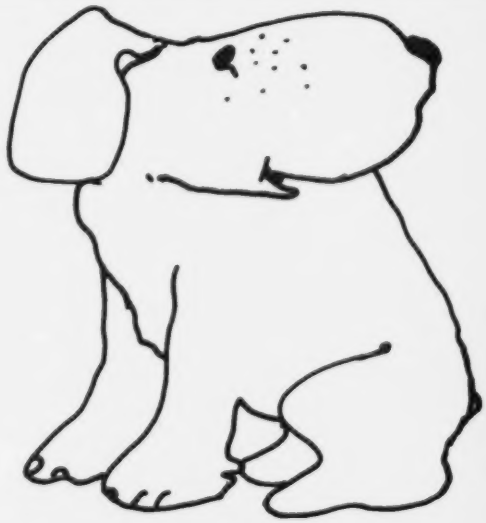


Lamp

Car



Dog



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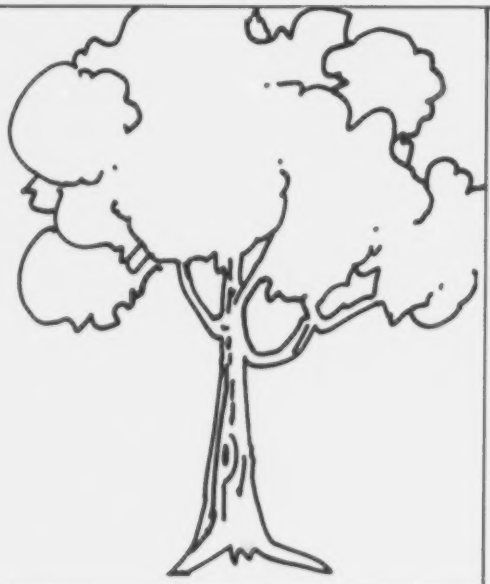
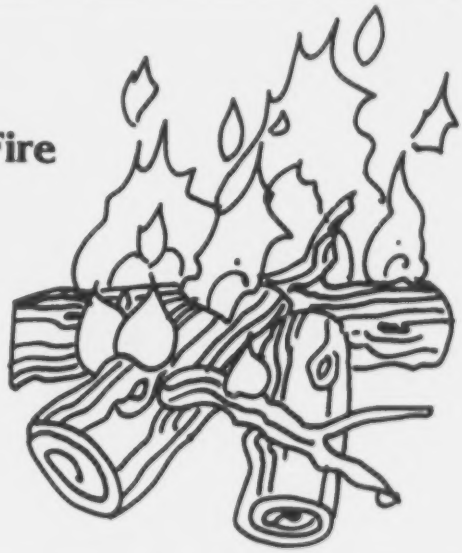
Where Does It Get Its Energy?

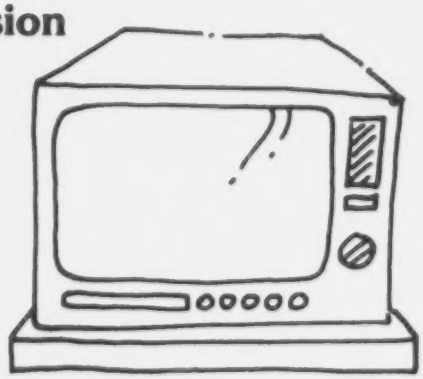
Tree



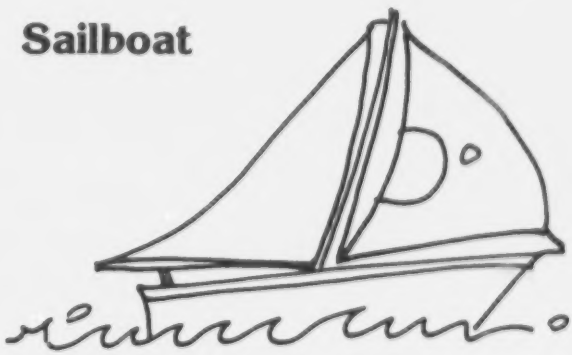
Fire



Television



Sailboat



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Where Does It Get Its Energy?

Directions: Cut out the energy words and paste them below the pictures they match.

Gasoline	Sun
Wind	Electricity
Wind	Food
Electricity	Wood

Energy Talk

Activity 5

Science, Art	Uses	Grades 2-3	Time 45 min.

Concept

Each form of energy can be used in many ways.

Activity Goal

The students will be able to identify energy sources.

What You'll Need

Samples of:

- Coal
- Water
- Wind (balloon of air)
- Wood
- Oil
- Food

What To Do

1. This activity is played much like the "20 Questions" game. Bring display samples of coal, water, oil, food, wind (a balloon of air), and wood to class. Discuss how each of these energy sources is used by filling in a chart, such as the one shown below, when students give suggestions. Accept as many responses as time and space permit.

Example:

Sun
homes
buildings
plants
heat
light
electricity

Coal
stoves
factories
trains
electricity

Water
waterwheels
dams
electricity

Wind
sailboats
boats
windmills
electricity

Oil
furnaces
electricity

Food
people
animals
plants

Wood
stoves
factories

Geothermal
heat buildings
electricity

Natural Gas
electricity
heat

Gasoline
cars
trucks
boats
lawnmowers

2. Select one student to choose an energy source for the game. He or she should keep its identity a secret from everyone but the teacher.

3. Have classmates ask questions that can be answered by "yes" or "no" about the energy source. The questions can reflect how the source is used and what it looks like. (Example: Is it used in cars? Is it black? Is it burned in a stove?)

4. After at least 10 questions have been asked by the group, a student may choose to pick up a source of energy and ask "Is it _____ (name of source)?" If the student is not correct, the questioning may continue or another student may attempt to identify the energy source. Students with incorrect guesses must wait until the next round is played. The first student with a correct guess becomes the leader of the next round.

Evaluation Idea

Have students create a mobile showing several energy sources and their uses.

Energy Trip Ticket Game

Activity 6

Science, Art, Social Studies	Uses	Grades	Time
		K-3	5x30 min.

Concept

Every energy use decision affects standards of living and quality of life.

Activity Goal

The students will realize that energy conservation affects our standard of living.

What You'll Need

- Magazines
- Glue
- Butcher paper
- Energy Trip Tickets (included with this lesson)

What To Do

1. Using magazine pictures, have students make collages depicting the use of energy—things moving or being moved—in one of the following areas:

A. Things we use at home.

B. Things we use and do for fun.

C. Things we use for transportation.

D. Things we do for work (jobs).

You may want students to work in small groups and then share collages with the class.

2. Class discussion: Compare the use of energy shown in each collage. How are they alike? How are they different? Which items on our collages make our lives easier and more comfortable? How?

3. To bring home the idea that it takes a lot of energy for people to have and do things, play the "Energy Trip Ticket Game":

A. To introduce the game to the students, list several places the students go in school.

Examples:

Lunch	Pencil sharpener
Recess/P.E.	Drinking fountain
Music	Restroom
Library	

Tell them each trip they take now costs one energy ticket.

B. Give each student 15 tickets. The student's name should be on each of his or her tickets. Alternatively the students could have deposit places marked with their names.

C. Keep a record of how many tickets the students have left each day. Which students are using more energy? Less energy? Making an effort to conserve? How are they conserving?

Discuss energy-saving ideas for trips around the classroom, e.g., at recess I can get a drink, sharpen my pencil, and go to the restroom for one ticket. Otherwise it would cost me four tickets to make trips one at a time. This stresses the idea that in one trip, several things can be accomplished.

D. On the third day, discuss the prospect of running out of energy tickets. There are not enough tickets left for the rest of the week. What can we do to save? What will it cost? What affect will it have on our classroom standard of living?

E. On the fifth day discuss the impacts the "energy

shortage" had on the use of energy—the number of trips students made.

4. Using the collages, ask students which activities would be affected most if a real energy shortage occurred. How would that influence our lives, use of energy?

Evaluation Idea

Create a classroom list of ways to conserve electricity at home.

Notes: _____

Power Bear **ENERGY** **TRIP TICKET** _____ Name	Power Bear **ENERGY** **TRIP TICKET** _____ Name	Power Bear **ENERGY** **TRIP TICKET** _____ Name
Power Bear **ENERGY** **TRIP TICKET** _____ Name	Power Bear **ENERGY** **TRIP TICKET** _____ Name	Power Bear **ENERGY** **TRIP TICKET** _____ Name
Power Bear **ENERGY** **TRIP TICKET** _____ Name	Power Bear **ENERGY** **TRIP TICKET** _____ Name	Power Bear **ENERGY** **TRIP TICKET** _____ Name
Power Bear **ENERGY** **TRIP TICKET** _____ Name	Power Bear **ENERGY** **TRIP TICKET** _____ Name	Power Bear **ENERGY** **TRIP TICKET** _____ Name
Power Bear **ENERGY** **TRIP TICKET** _____ Name	Power Bear **ENERGY** **TRIP TICKET** _____ Name	Power Bear **ENERGY** **TRIP TICKET** _____ Name

Do Electrical Appliances Save Time?

Activity 7

Science, Art, Mathematics, Language Arts	Uses	Grades 2-3	Time 60 min.

Concept

Every energy use decision affects standards of living and quality of life.

Activity Goal

The students will recognize how people use energy at home to do work that once was done by hand.

What You'll Need

- Electric drill, hand drill
- Electric mixer, egg beater, bowls, flour, water
- Electric can opener, hand can opener
- Electric knife, hand knife
- Bar of soap
- Cutting block
- Block of wood
- Empty cans
- Collage material (magazines, scissors, glue)

What To Do

1. To get the students thinking about the amount of human energy spent and the amount of time it takes to do things, ask them if they would rather walk, ride a bike or ride in a car five miles to a friend's birthday party.

A. Ask them why they chose what they did.

B. Which would take the most time? The least?

C. Which would take the most human effort? The least?

D. Which would be the best exercise? Why?

2. After the discussion, demonstrate an electric knife, electric can opener, electric mixer, and electric drill to illustrate how people use energy to save time and effort. Have students record the amount of time that passes as you:

A. Cut a bar of soap with the electric knife and a hand knife.

B. Drill a hole in a block of wood with an electric drill and a hand drill.

C. Mix flour and water with an electric mixer and a hand mixer.

D. Open the bottom of empty cans with an electric can opener and a hand can opener.

3. Construct a bar graph similar to the one shown on the following page to illustrate the results of Step 2. Explain that we often use energy to make work easier and to save time.

4. Point out both the advantages and disadvantages of using convenient devices. Be sure to relate this to the standard and quality of life.

5. Make a collage showing the home appliances people use to reduce their work. Have students cut pictures from old magazines and catalogs.

Evaluation Ideas

Have students list at least four home appliances that are used to make work easier or to save time.

Have students write about how life would be different without electricity.

60

Do Electrical Appliances Save Time?

	Soap		Wood		Flour & Water		Cans	
Time (Seconds) 150								
140								
130								
120								
110								
100								
90								
80								
70								
60								
50								
40								
30								
20								
10								
Appliance Or Device Used	Electric Knife	Hand Knife	Electric Drill	Hand Drill	Electric Mixer	Hand Mixer	Electric Can Opener	Hand Can Opener

Electrical Safety Tips From Power Bear

Activity 8

Science, Art, Language Arts	Uses	Grades K-3	Time 2×60 min.

Concept

There are health and safety factors associated with the development and use of energy resources.

Activity Goal

The students will learn basic rules for using electricity safely.

What You'll Need

- Copy of coloring book for each student
- Crayons

What To Do

1. Give each student a copy of the coloring book.

2. Read and discuss each page of the coloring book, emphasizing why it is important to be careful when using electricity.

3. Discuss possible electrical hazards. Make a list on the chalkboard and then discuss possible corrective actions. (Examples: more than one extension cord in an outlet; cords that can be walked on or tripped over; worn extension cords; pulling cord from outlet; using fork to remove toast from toaster; appliance near water faucet.)

4. Have the students color the pages.

Career Awareness Idea

Invite a representative from the local electric utility or fire department to visit the class and discuss electrical safety.

Evaluation Idea

Have the students share the safety rules they've learned with their families and friends. Afterward, take a survey to see how many people your class has reached with the electrical safety message.

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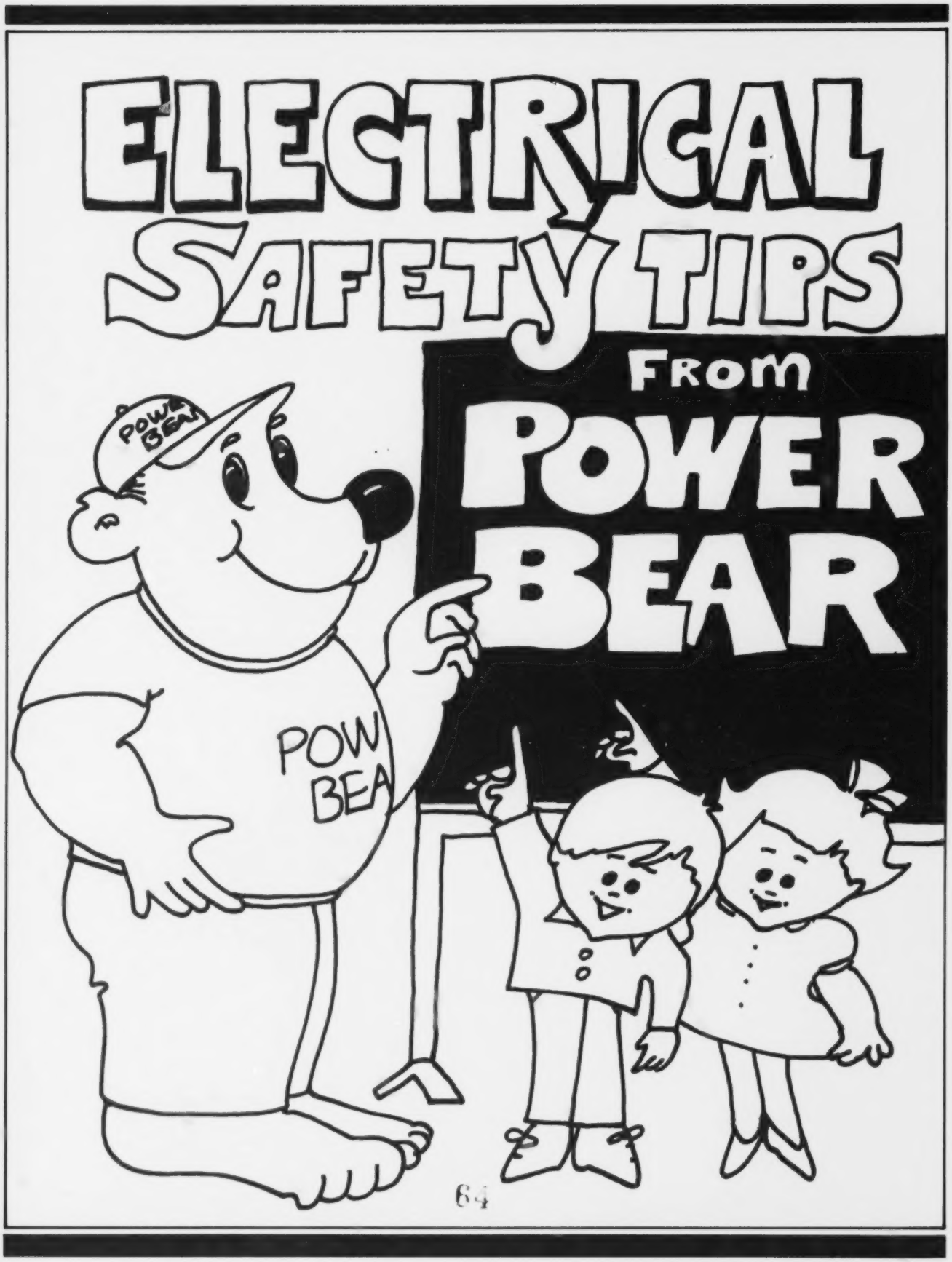
ELECTRICAL
SAFETY TIPS
FROM
POWER
BEAR
POW
BEA
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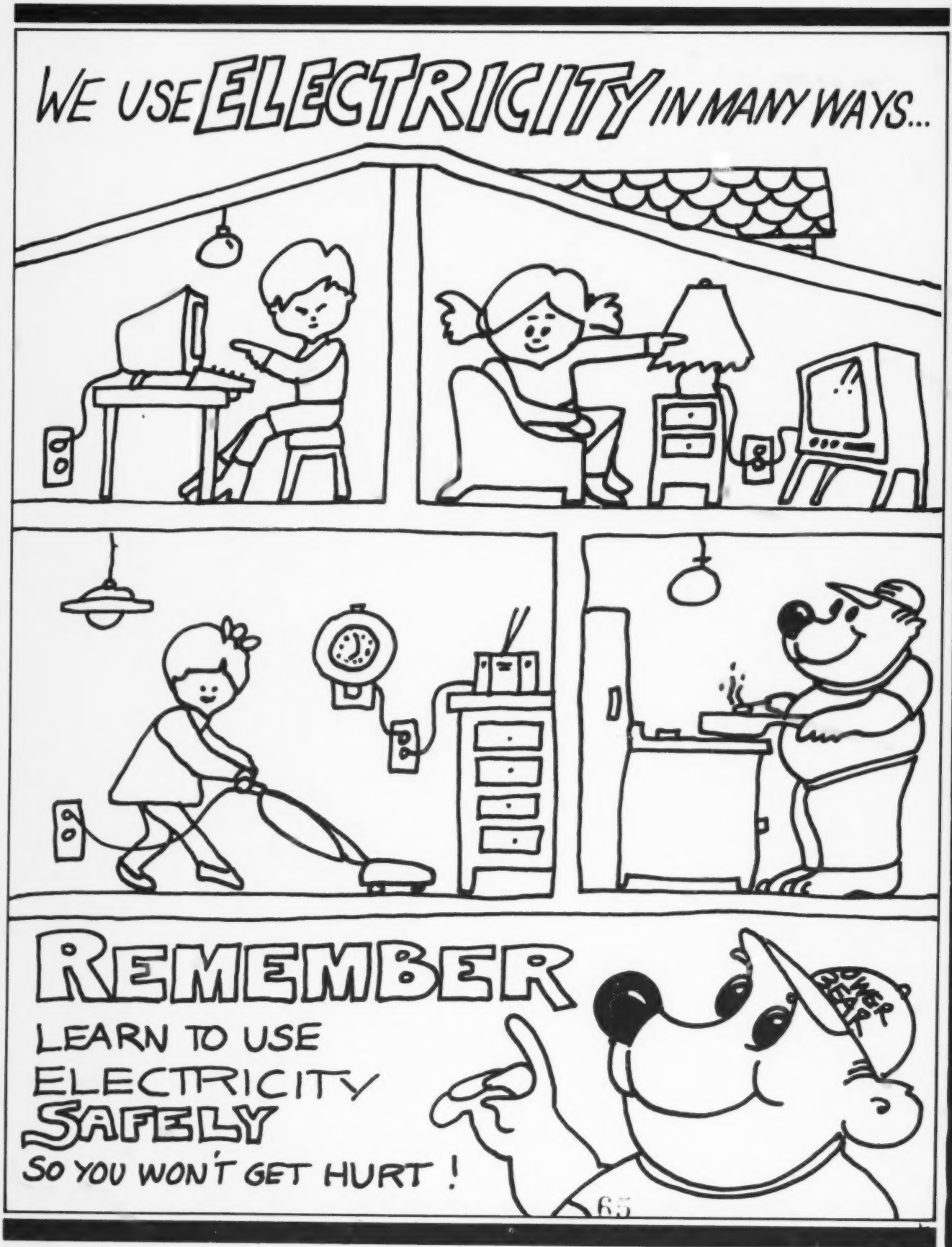

WE USE ELECTRICITY IN MANY WAYS...
REMEMBER
LEARN TO USE
ELECTRICITY
SAFELY
SO YOU WON'T GET HURT !
POWER BEAR
65

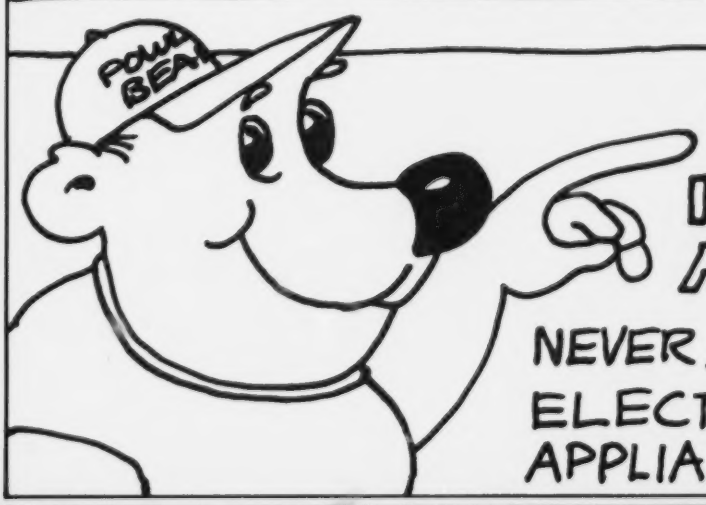
DON'T PLAY
NEAR POWER
COMPANY EQUIPMENT
SUBSTATION
NO!
STAY
AWAY!
TRANSFORMER
BOX
POWER
BEAR

MAKE SURE
THE TREE
YOU CLIMB IS
NOT NEAR A
POWER LINE
KEEP
FAR
AWAY

BE CAREFUL

TO KEEP ELECTRICAL APPLIANCES AWAY FROM

WATER



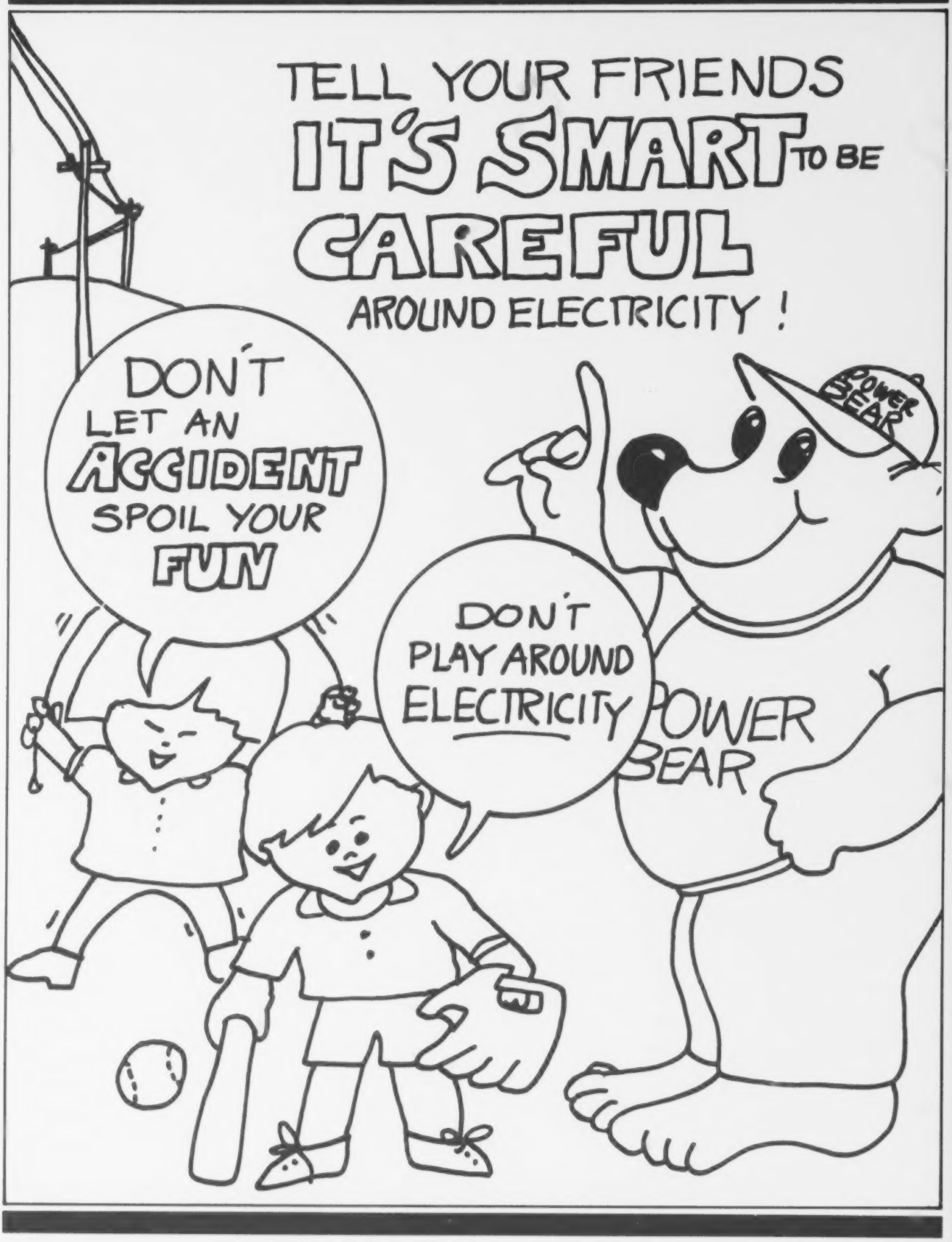
REMEMBER

IF YOUR HANDS ARE WET

NEVER, EVER TOUCH AN ELECTRIC CORD OR APPLIANCE !!!

BE ON THE LOOKOUT
FOR ELECTRICAL
HAZARDS
LIKE
THESE...
A
FRAYED WIRE
A
BROKEN PLUG
IF YOU SEE A
BROKEN CORD
OR PLUG - DON'T TOUCH!
LEAVE IT AND
TELL AN ADULT!

LOOK UP
BEFORE FLYING A KITE.
PLAY
SAFELY
AWAY FROM
POWER
LINES.
POW
BE
IF YOUR KITE GETS NEAR A POWER LINE, LET GO! HAVE AN ADULT CALL THE POWER COMPANY IF IT GETS CAUGHT IN THE WIRES. DONT TOUCH THE STRING.


TELL YOUR FRIENDS
IT'S SMART TO BE
CAREFUL
AROUND ELECTRICITY !
DON'T
LET AN
ACCIDENT
SPOIL YOUR
FUN
DON'T
PLAY AROUND
ELECTRICITY
POWER
BEAR
POWER
BEAR

Energy, Work and Movement

Activity 9

Science	Conversions	Grades	Time
		K-3	2x40 min.

Concept

Energy is the capacity to do work.

Activity Goal

The students will determine that it takes energy to move an object, and that energy is often converted from one form to another.

What You'll Need

- Copies of picture, "Energy: What in the World is It?"
- Five or six ping pong balls
- Box
- Stick
- Blow dryer
- Wind-up toy

What To Do

1. Introduce the class to new scientific meanings of the words "energy" and "work":

A. Read the following to the class:

This is a story about the world we live in. Every day—whether it's cloudy or bright—the sun shines on our world creating heat and light that support plant and animal life. The heat and light from the sun grows our food, creates the wind and waterpower, and even, many millions of years ago, was the source of energy for the decayed plants and animals that made the fossil fuels called oil, coal, and natural gas.

The people in our world go to their jobs and go to school; they play. And when the sun sets at night, they are tired and they say, "Whew, I ran out of energy!" In the morning, after a good night's sleep and a big breakfast, the people in our world feel "full of energy" again.

B. Give each student a copy of the picture, "Energy: What in the World is It?" Discuss how the picture shows all kinds of energy.

Energy is the power to make things move; energy creates light; and energy makes heat. Energy is the ability to do work. And, in scientific terms, work is not those things we do like scrubbing the kitchen floor. Work is done any time a force causes an object to change its movement or shape.

C. Have the students do the following to the picture:

(1) Mark everything that moves with an M.
(2) Mark things that light with an L.
(3) Color every place where work is happening.
(4) Mark things that give off heat with an H.
(5) Color all the areas in the house that are using electricity.

2. Once students have been introduced to the scientific meanings of "energy" and "work," have them apply what they've learned to a simple classroom activity:

A. Place the ping pong balls in the box. Ask the children to consider all the

ways that the balls could be made to move. If possible, try each suggestion and ask where the energy came from.

B. Move by hand. Develop the energy conversion cycle of where the hand's energy comes from (human energy, food, solar). If we put food beside the ball, can it move? Or can sunshine move the ball? The energy needs to be converted in order to do work—move the balls.

C. Move balls with a stick. Where did the energy come from? Can the stick move the ball all by itself?

D. Move balls with a blast from a blow dryer. Where did the energy come from? (electricity—blow dryer)

E. Tip the box. Where did the energy come from? (human energy)

F. If the balls are placed on a tilted surface, what happens? What energy was working then? (gravity)

G. Use the wind-up toy. Where does the energy come from? (battery)

H. Discuss the energy sources of appliances in the classroom. For example: clock, projector, record player. Emphasize that in order for work to be done—things to move—energy must be used (converted).

Evaluation Idea

Have students give examples of using energy to do work.

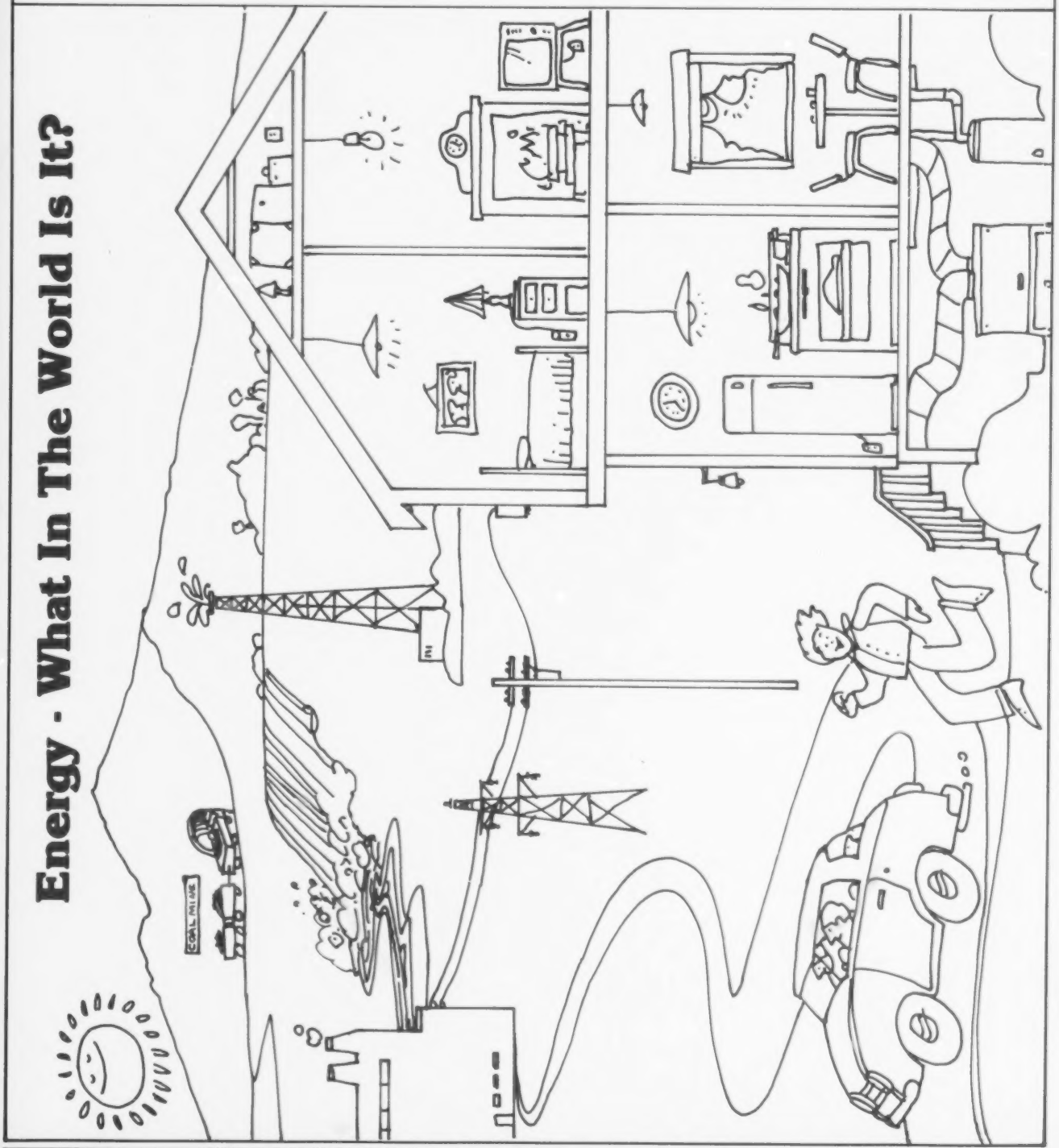
Notes: _____

Energy, Work and Movement

Name _____

Date _____

Energy - What In The World Is It?



A Bright Idea

Activity 10

Science	Conversions	Grades 2-3	Time 60 min.

Concept

Energy occurs in many forms.

Activity Goal

The students will study an example of potential energy converted to energy in the forms of heat and light.

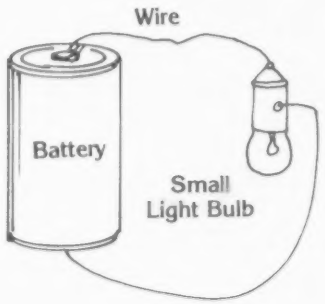
What You'll Need

- Several general purpose D-cell batteries
- Pattern for battery holder
- Brass paper fasteners or "brads"
- Pieces of insulated wire
- Rubber bands
- Screwdrivers
- Small flashlight bulbs and sockets

What To Do

1. Demonstrate a battery-operated toy with and without the battery. Explain that energy is the ability to move an object. Energy lights light bulbs.

2. Explain to students that the battery contains stored energy, or energy that has not yet been used. This is called potential energy. Show the students how to tap the energy from the battery by hooking up the wires to the battery and light bulb. Discuss each step you perform, since the students will be asked to do the same in small groups.



Explain to students that when the light is on, energy (electricity) is being used to do work (move electrons to make light and heat). While the light bulb is on, discuss:

A. How we know the energy from the battery is working.

B. What kinds of energy the bulb is giving off.

C. That the battery converts chemicals (chemical energy) to electricity (electrical energy) and that the light bulb converts electricity to light and heat energy.

3. Have students assemble their own battery holders, using the pattern and instructions provided.

If enough materials are available, have the students form groups of four or five. Give them the materials needed to perform the activity in step two, following your instructions.

As the students do the activity, have them note the light and heat energy given off.

4. Give students examples of types of potential and active or kinetic energy.

Kinetic energy

a person riding a bicycle
a fire in a wood-burning stove
a person running
a moving automobile

Potential energy

a lump of coal
a battery
a sandwich
a rock at the top of a hill

Career Awareness Idea

Have an electrician or electric utility employee discuss his or her job.

Evaluation Idea

Fill in the blanks using the words below:

1. A battery converts chemical energy into _____ energy.
2. Electricity is a form of _____ energy.
3. The light bulb converts electrical energy into _____ and _____ energy.
4. A battery contains _____ energy.

Word choices:
Electrical, Heat, Kinetic, Light, Potential

Answers:
1. Electrical
2. Kinetic
3. Light, Heat
4. Potential

Notes: _____

Assembling Your Own Battery Holder

1. Cut out the rectangle.

2. Cut out the rectangle on the dotted lines marked "cut." You'll be making four cuts.

3. Fold the rectangle on the solid lines marked "fold." You'll be making four folds.

4. On one end of the rectangle, place blocks B and A on top of block C.

5. Using a brass paper fastener or "brad," punch a hole through the centers of A, B, and C.

6. Fasten the brad so that its "head" will be inside the box and its "arms" are on the outside.

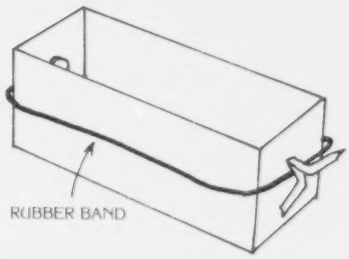
7. Repeat steps 4, 5 and 6 at the other end to finish the box.

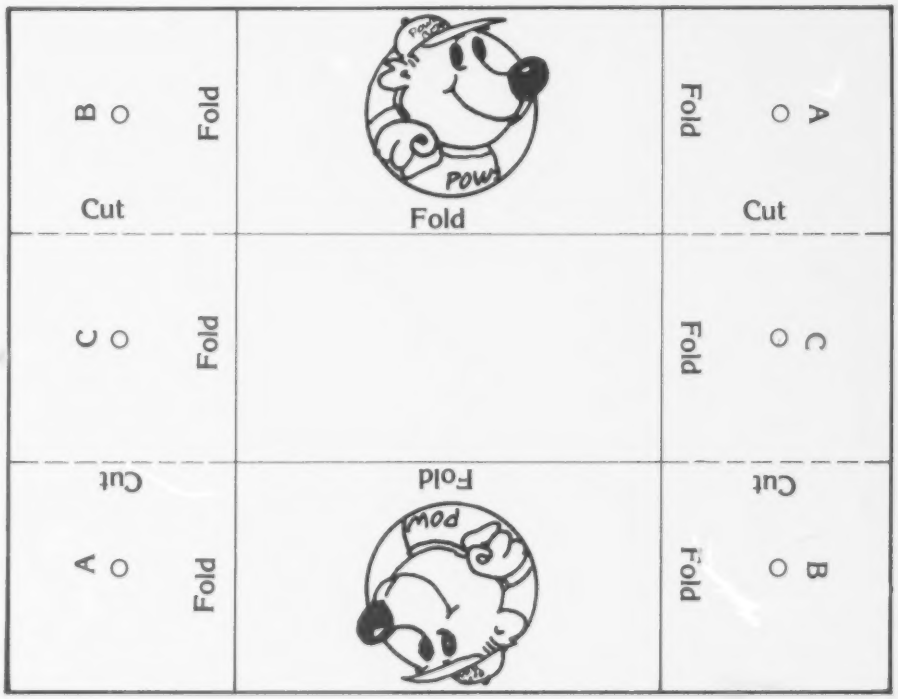
8. Wrap a piece of wire that has been stripped at the ends around the "arms" of each brad.

9. Place a battery in the box.

10. To keep your battery snugly in place, stretch rubber band over the box from end to end.

11. Congratulations! You've just constructed a battery holder.





Food Chains

Activity 11

Science, Art	Conversions	Grades 2-3	Time 2×45 min.

Concept

All energy conversions are subject to natural laws.

Activity Goal

Students will create and illustrate a food chain.

What You'll Need

- "Food Chains" worksheet for each student
- Paper
- Crayons
- Song cards (included with this lesson)
- "Hi O The Universe, The Sun Is In The Sky" song sheet

What To Do

1. Introduce the students to a simple food chain by putting an example on the chalkboard. (Example: sun — grass — sheep; explain that the sun provides energy for grass to grow and the grass provides energy [food] for sheep.)

2. Using the song sheet, teach students the song, "Hi O The Universe, The Sun Is In The Sky."

3. Begin the song by having the class form a circle.

4. Tape the song cards on selected students to identify their parts in the song.

5. As a group, sing the song. As each player is chosen, he or she goes into the circle.

6. Repeat the song as many times as desired. Choose different students to wear the song cards.

7. Have students choose an animal and research information to answer the questions on the student worksheet, "Food Chains."

Suggestions:

Cows	Chickens
Sheep	Ducks
Fish	Rabbits
Pigs	Deer

8. Have the students report their findings to the rest of the class.

9. Using the illustration on the worksheet, have each student draw pictures in the links to illustrate a food chain including the animal he or she chose to research. The food chain should include: the sun; a plant; one or more animals; a person.

10. Display the "food chain" pictures in the classroom.

Evaluation Idea

Have each student select and explain a food chain created by another student in the class.

Notes: _____

Food Chains

Name _____

Date _____

1. Name of animal: _____

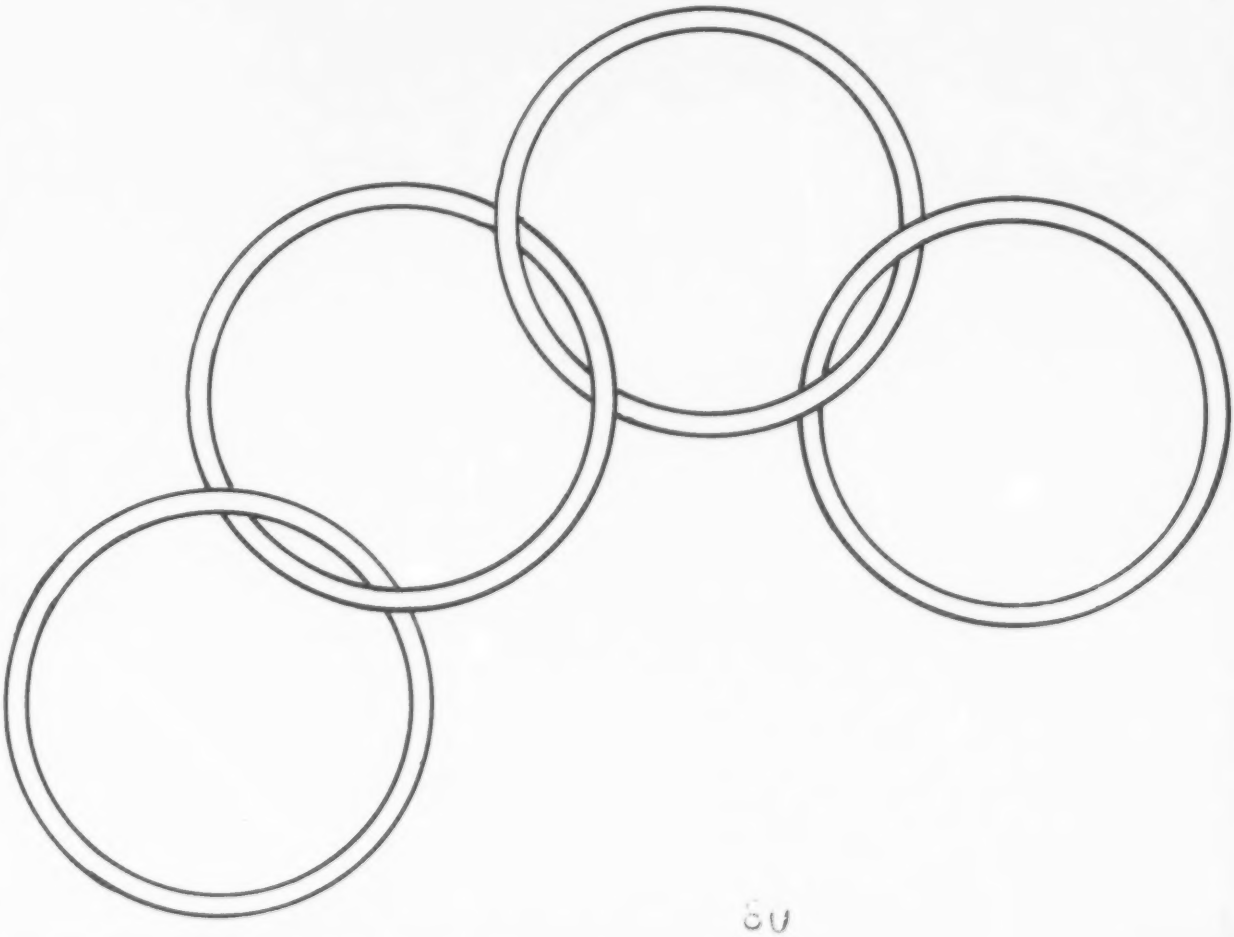
2. What does the animal eat? _____

3. Where does the food the animal eats get its energy? _____

4. List the types of food that come from the animal and put a check beside the foods that you eat. _____

_____

_____



Song Sheet

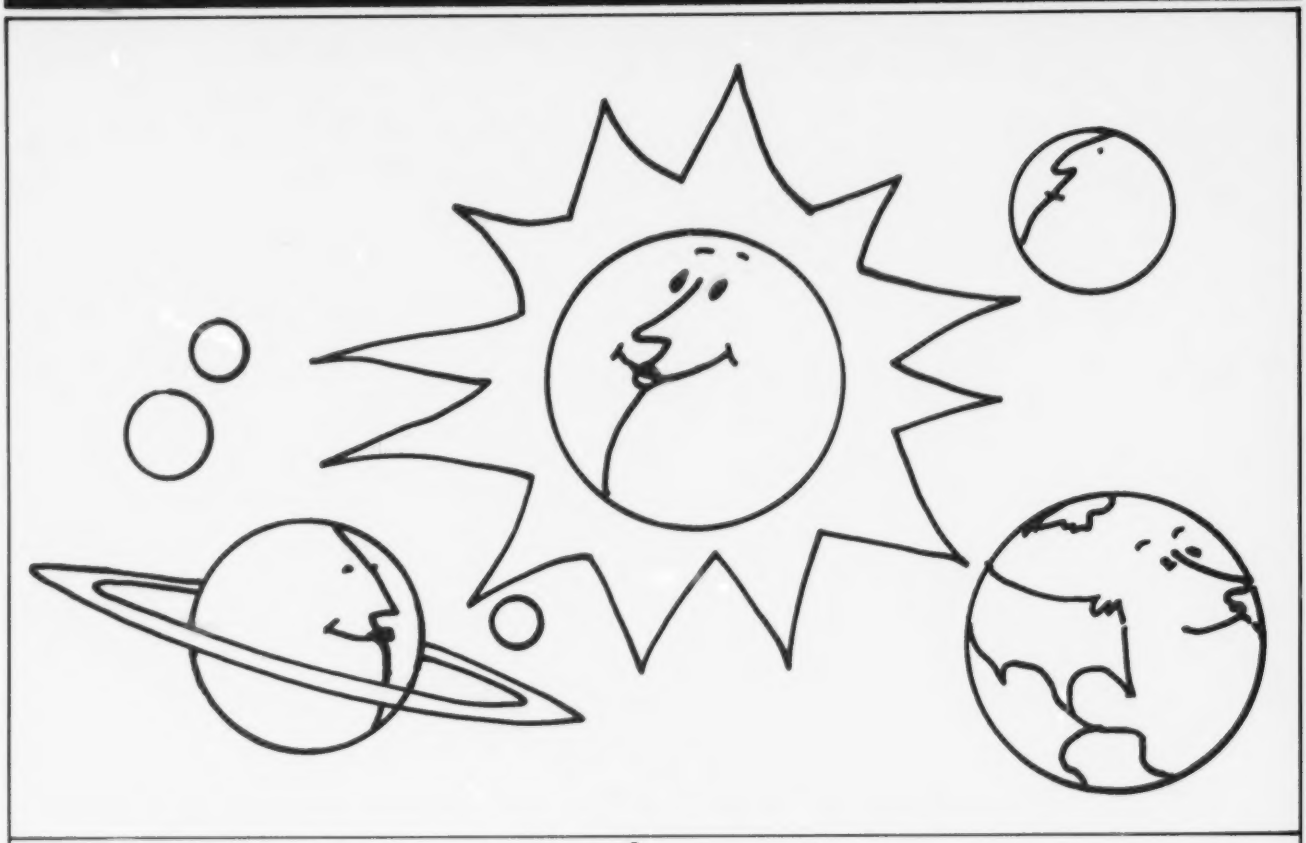
Directions: Sing to the tune of "The Farmer In The Dell"
As each player is chosen, he or she goes into the circle.

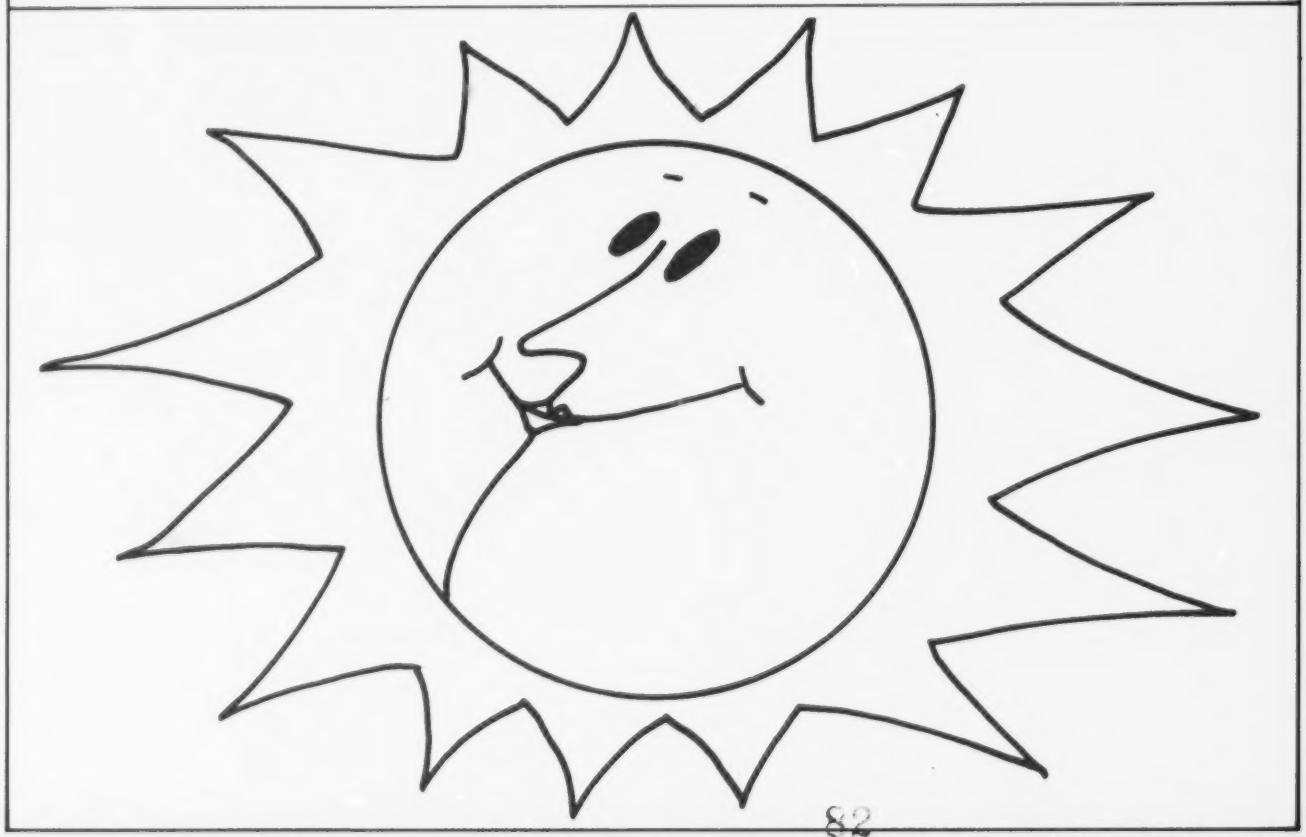
Hi O The Universe, The Sun Is In The Sky

The sun is in the sky,
The sun is in the sky,
Hi O the Universe, the sun is in the sky!
The sun chooses the earth,
The sun chooses the earth,
Hi O the Universe, the sun chooses the earth.
The earth chooses the seed,
The earth chooses the seed,
Hi O the Universe, the earth chooses the seed.
The seed grows a plant,
The seed grows a plant,
Hi O the Universe, the seed grows a plant.
The plant feeds a cow,
The plant feeds a cow,
Hi O the Universe, the plant feeds a cow.
The cow feeds a child,
The cow feeds a child,
Hi O the Universe, the cow feeds a child.
(All clap their hands and rejoin the circle and leave one child alone in the circle.)

Can the child stand alone?
Can the child stand alone?
Hi O the Universe, can the child stand alone?

(All shout together, "NO! The child needs energy from the sun!"
(Give time for other answers and ideas.)





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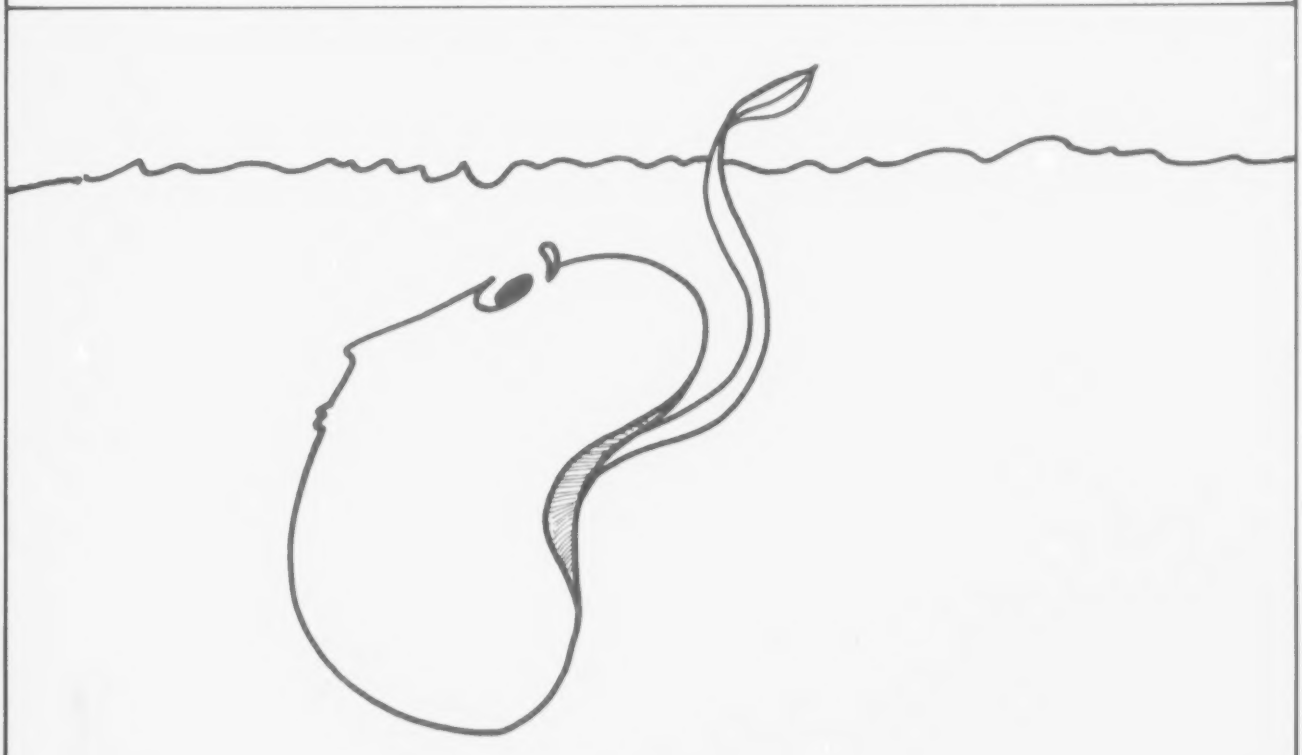

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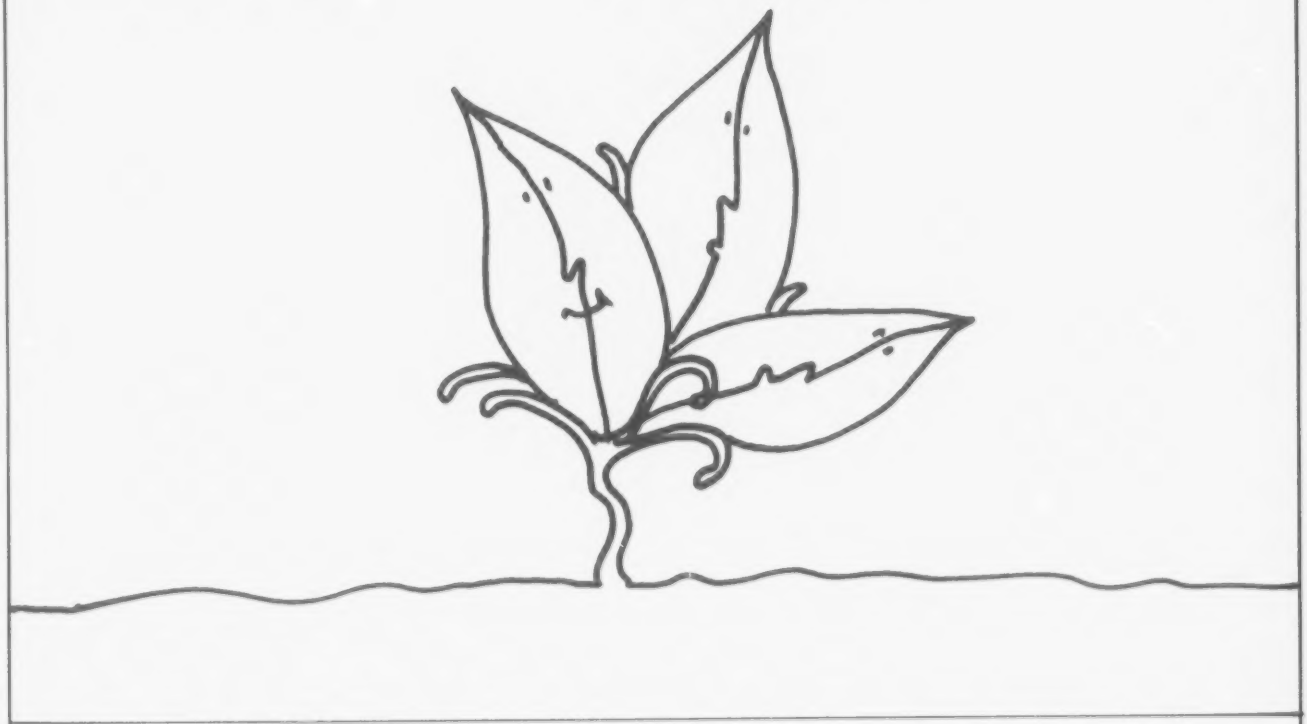
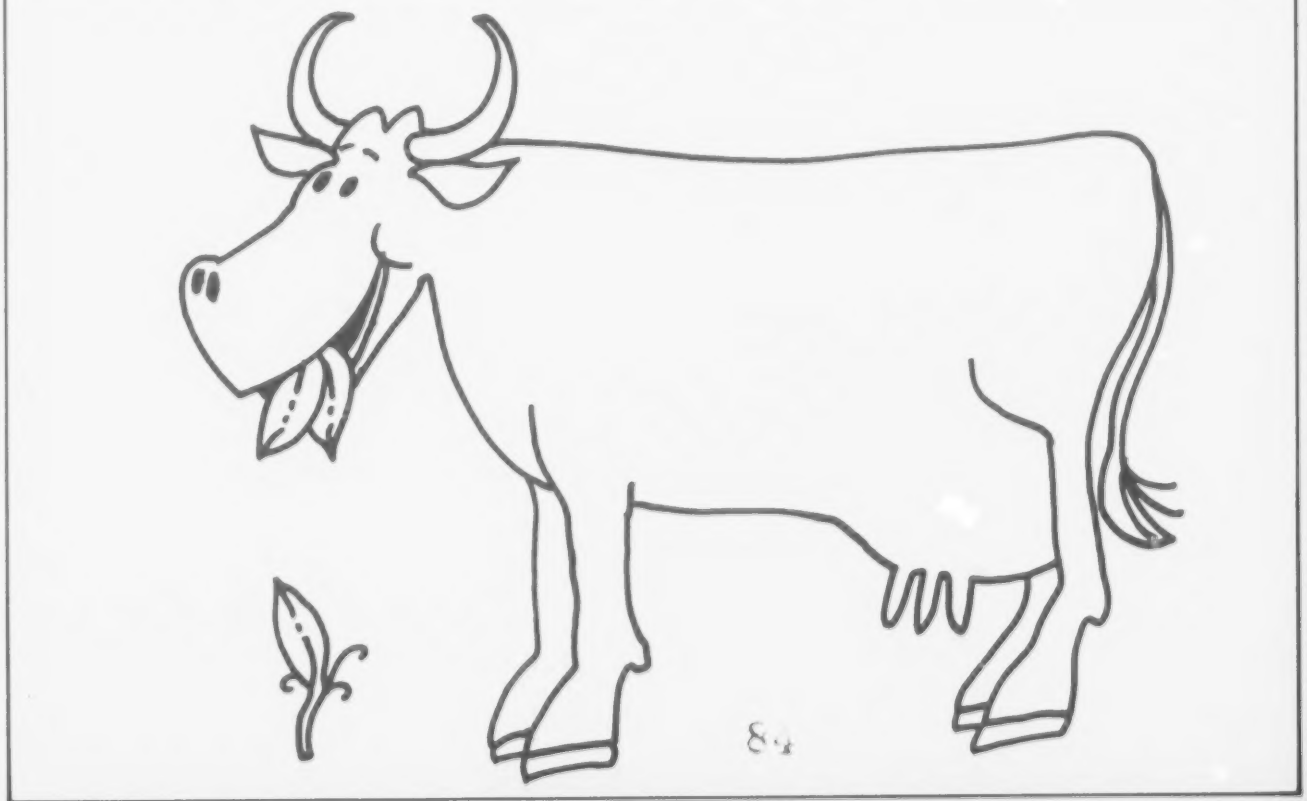
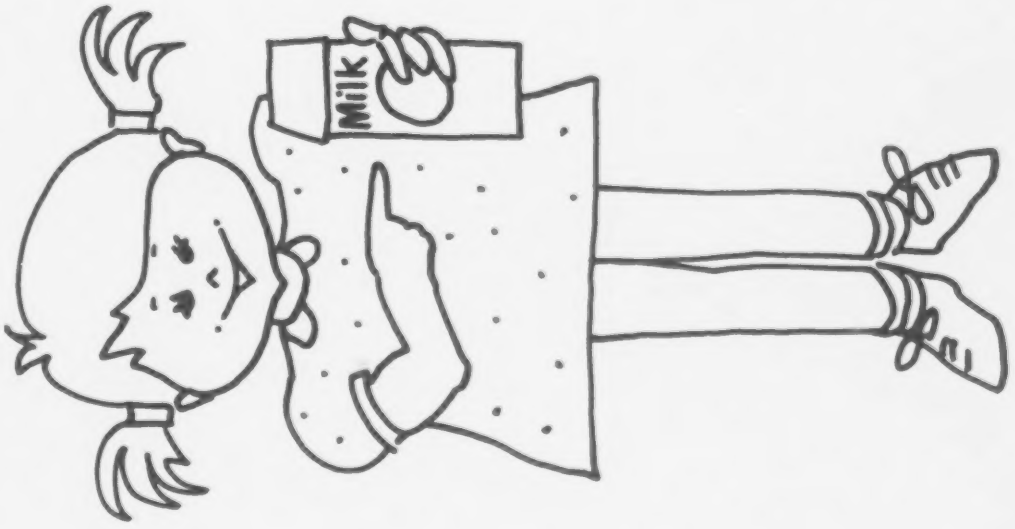
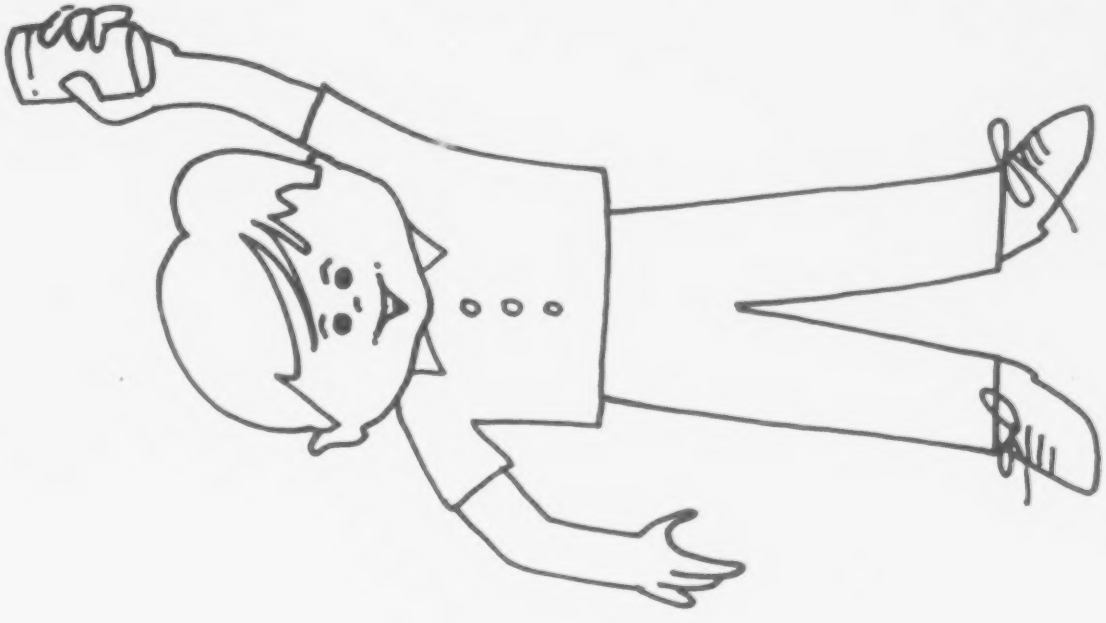





Milk



Energy For Electricity

Activity 12

Science	Conversions	Grades	Time
		K-3	60 min.

Concept

There are man-made and natural energy conversion systems.

Activity Goal

The students will observe an artificial conversion system.

What You'll Need

- Tea kettle
- Hot plate
- Pinwheel
- Cooking or scientific thermometer
- Beaker or can
- Energy For Electricity Puzzle - one for each student

What To Do

1. Explain to students that one form of energy can be changed (converted) to another. For example, the energy of coal, natural gas, or oil can be converted to heat energy. Have students share what they know about steam. Name various uses for steam such as steam heat for buildings, steam engines, or the use of steam to produce electricity. Ask students what was converted to make steam.

2. Teacher Demonstration: Using a hot plate, boil water in a tea kettle. As the steam rises place a pinwheel in the path of the steam. Explain that the heat energy was used to boil the water to create steam. The force of the steam moves the pinwheel.

Discussion:

A. How long did it take the water to boil?

B. How long did it take the wheel to begin turning?

C. How long does it continue turning?

D. What happens to the heat energy produced by the hot plate?

E. Is all the steam being used to turn the wheel?

F. Ask the student where the hot plate gets its energy.

3. Tell students how heat is used to generate electricity: Coal, oil, or natural gas can be burned to produce heat energy. The heat energy is then used to turn water into steam. The steam is then used to turn a turbine (a pinwheel-like machine), which spins a generator (made of magnets and coils of wire). The generator produces electricity.

Evaluation Idea

Give students the "Energy For Electricity Puzzle." Have students cut along the dotted lines and put the pieces in order showing how a steam power plant works. The students can also color the pictures.

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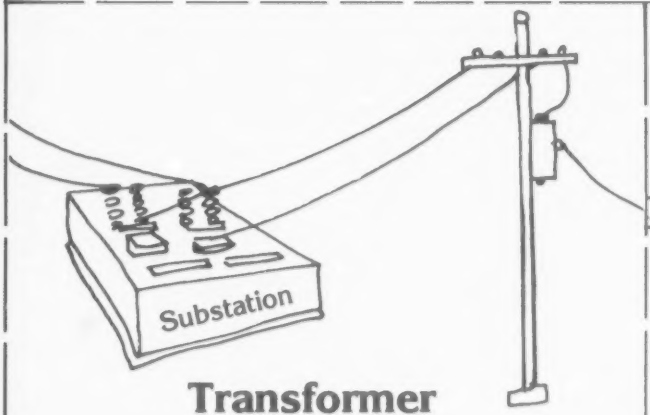
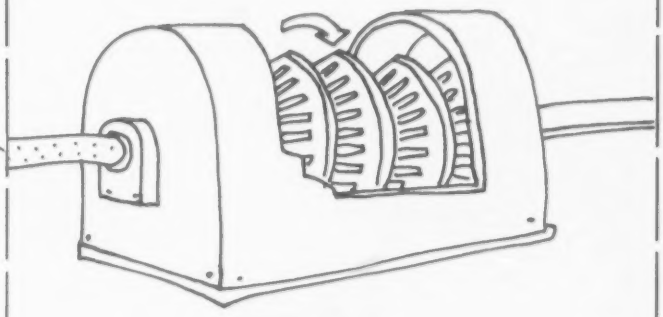
Energy For Electricity Puzzle

Name _____

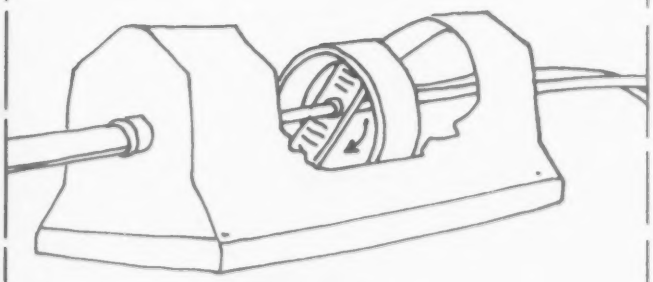
Date _____



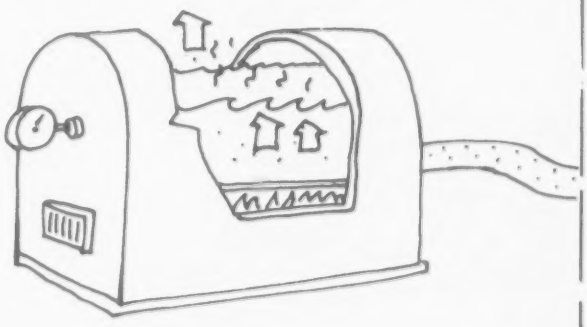
Transformer



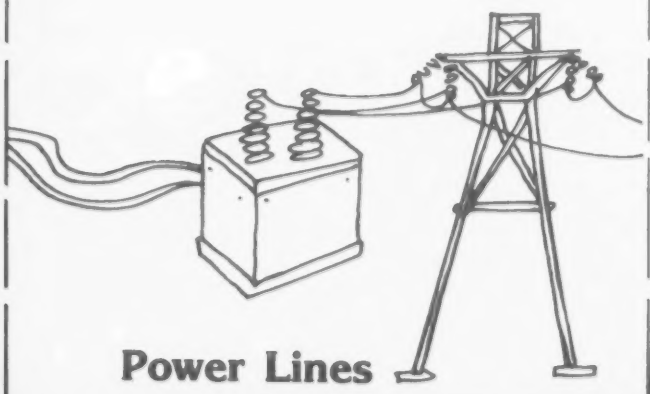
Turbine



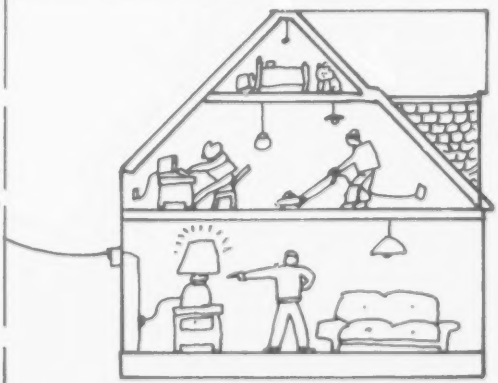
Generator



Boiler



Power Lines



Consumer

Energy To Grow On

Activity 13

Science	Conversions	Grades	Time
		K-3	3x30 min.

Concept

There are man-made and natural energy conversion systems.

Activity Goal

Students will observe a natural conversion system.

What You'll Need

- Plant container for each student (paper cup)
- Potting soil—enough for each student's container
- Seeds - bean or popcorn

What To Do

1. Have students obtain small containers in which to grow plants, prepare a soil mixture and plant their seed(s) of choice.

2. After seeds have germinated, place several plants in the dark. Place the rest in the sunlight.

A. Observe the plants in both situations once a day for several weeks. Discuss the differences between the two.

B. Questions to discuss:
— What do you observe about the plants in the dark?
— What do you observe about the plants in the light?
— Which plants look the healthiest and why?
— What does the sun's energy or light do for the plants?
— How did the plant use the sun's energy?
— Will the plant bend toward the sunlight when turned in various positions?
— Does this show the plant is affected by the sun?

3. Explain that plant growth is the result of conversion of the sun's energy. Plants will not grow or produce food (for the plant or for other people or other animals) without the sun's energy.

Career Awareness Idea

1. Invite a gardener to come to speak to the class about his or her hobby. Have the speaker emphasize the importance of direct and indirect lighting and shade in growing things.

2. List names of jobs in which people work with plants (e.g. farmer, horticulturist, florist).

Evaluation Idea

Have students start and care for their own plants. List things the plant will need to grow well: air, sun, food (fertilizer), water.

Notes: _____

Food, Energy and You

Activity 14

Science, Mathematics, Language Arts	Conversions	Grades 2-3	Time 7x30 min.

Concept

There are man-made and natural energy conversion systems.

Activity Goal

The students will keep track of the number of calories consumed in their school lunches and become aware that food is converted to energy in their bodies.

What You'll Need

- ½ peanut (shelled) and an equal amount of walnut
- Postage scale or other small scale
- Cork
- Thermometer
- Straight pin
- Small tin can
- Aluminum foil
- Wire coathanger or stiff wire
- Safety matches or cigarette lighter
- Calorie counter (booklet)

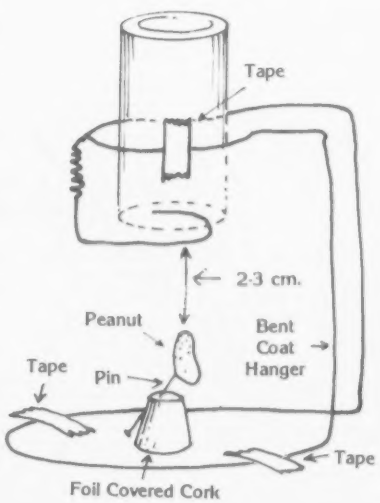
What To Do

1. Teacher Demonstration: Food Has Energy!

A. Using a small scale weigh the peanut and walnut to verify they are the same weight.

B. Cover cork with aluminum foil. Stick a straight pin through the side of the cork and then into the peanut.

C. Bend wire coathanger to make a frame for the tin can. Tape wire to tin can and to table for added stability:



D. Put cork and peanut 2 cm from the tin can. Add books or cardboard to raise the cork, or bend the frame down lower.

E. Fill the tin can ¾ full of cold water. Record the temperature.

F. Set fire to the peanut, and record the water temperature after burning.

G. Starting with cold water again, repeat steps E and F using the walnut.

H. Discussion:

— Explain that nuts and seeds are high calorie/high energy foods to support growth of new plants.

— Ask students which nut raises the water temperature more. (Have students support their answers.)

— Ask students if food has energy. Where does the food's energy come from?

— Define the term calorie. (Calorie: a unit of heat energy equal to the amount of heat that will raise the temperature of one gram of water one degree Celsius.)

2. Class project: Counting Calories

A. Using a calorie counter, keep track of calories consumed in school lunches for one week. Record them on a chart. Have students make a chart similar to the one shown below.

B. Discuss with students how our bodies use food's energy: to keep us warm, for growth, and for movement.

C. Have students name ways energy is used to bring food to the lunchroom: farming, processing, packaging, transporting, storing, cooking. Then have them select favorite foods and develop diagrams showing the energy used to put them on the table.

Optional Activity

Keep a height and weight (growth) chart on each student. Relate this to food energy converted by our bodies.

Career Awareness Idea

Have students interview the school dietician about his or her job in preparing food; specifically ask about planning healthy meals.

Evaluation Idea

Ask students the following questions:

1. Where does food get its energy?
2. How is energy used to bring food to people?
3. How does the body use energy?
4. What are some human and natural energy conversions needed to get food to you?

Notes: _____ _____

Day	Lunch (List only foods you ate for lunch)	Calories
Monday		
Tuesday		
Wednesday		
Thursday		
Friday		
	TOTAL	

91

Electricity: Who Needs It?

Activity 15

Science, Social Studies	Conversions	Grades 2-3	Time 30 min.

Concept

Changes in energy conversion technology have resulted in technological and industrial change.

Activity Goal

Students will recognize that electricity plays a big role in their lives.

What To Do

1. Read the following story to the students and have them decide what they would do without electricity:

Imagine a day that starts something like this. You roll over in your bed, open your eyes, and discover that the morning seems much brighter than it usually does at the start of your day. You check your alarm clock, but that turns out to be no help at all. It is stopped at 12:00. You know that's not right! You jump out of bed and bound into the kitchen. The battery-operated clock on the wall tells you that you have only 15 minutes to get to school—just enough time for a quick slice of toast and a cup of instant hot chocolate.

Before you go back to your room to get dressed, you pop a slice of bread into the toaster and boil some water in the microwave. When you get back to the kitchen, you find that everything is exactly the way you left it — the bread is untoasted and the water is cold.

And that's only the beginning!

Suppose the electricity in your community has been shut off indefinitely. And suppose everyone in your family is in good health and there is plenty of food in the house. You shouldn't have any problems. Right?

Well, without electricity how would you and your family:

Cook your food?
Wash the dishes?
Open cans?
Make toast?
Bake a cake?
Store food in summer?
Store food in winter?
Wash the clothes?
Keep warm in winter?
Have light in your house?
Entertain yourselves?
Get to the sixth floor of a building?
Get a weather report?

2. Ask students how they think the activities above were done 100 years ago.

Evaluation Idea

Have students keep a 24-hour log of the ways they use electricity. Whose list is longest? Shortest? What uses did students forget to add to their lists? Which items do all students have in common? What unusual appliances and uses appear in their logs? Come to some conclusions about the class' energy use.

Notes: _____

Energy At Work

Activity 16

Science, Art	Impacts	Grades K-3	Time 2×30 min.

Concept

Economic factors influence energy source discovery, development, distribution and use.

Activity Goal

The students will identify occupations related to energy production and use.

What You'll Need

- Worksheet puzzle for each student
- Occupation flashcards included with this lesson
- Crayons

What To Do

1. Explain to the students that many people's work makes it possible for us to use energy. Using the occupation flashcards, show examples to the students. (Examples: meter reader, electrician, gas station attendant, coal miner, scientist.) Discuss with the students the importance of these occupations.

2. Ask the students if any members of their families work in occupations that are related to the production or delivery of energy.

3. Have the students do the worksheet puzzle, matching the occupations and the workers. Students can also color the page.

4. When students have completed the puzzle, review the answers and discuss how each occupation relates to our energy use.

Career Awareness Idea

Invite a representative from your local electric utility company to discuss a variety of occupations in the electric company.

Evaluation Idea

Ask the students to name two occupations that are energy related.

Notes: _____

_____

_____

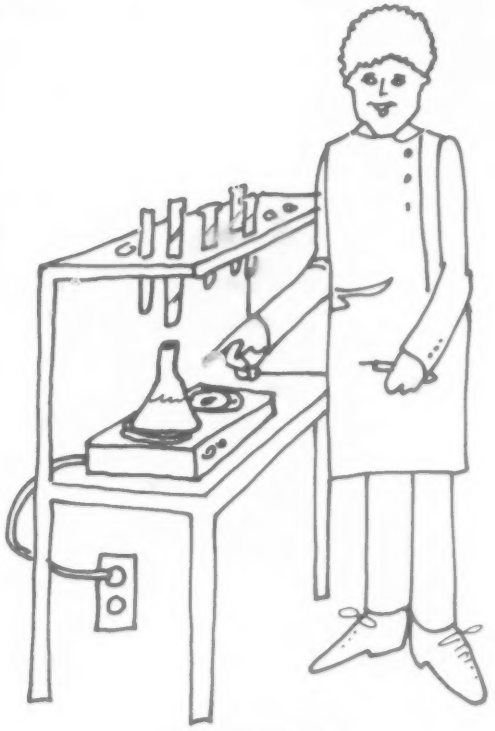
_____

_____

_____

_____

Energy At Work

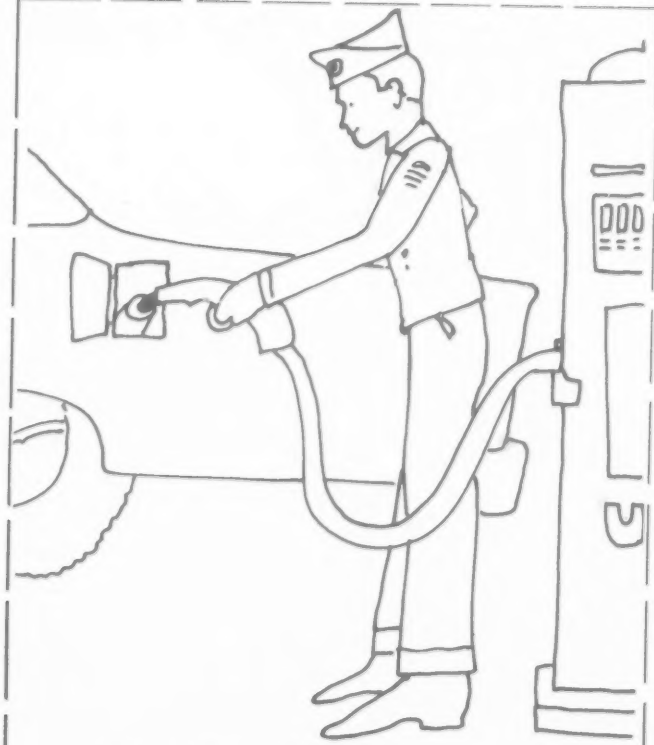


Scientist

Office Worker

Meter Reader

Electrician



Gas Station Attendant

95

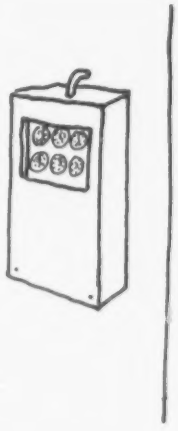
Coal Miner

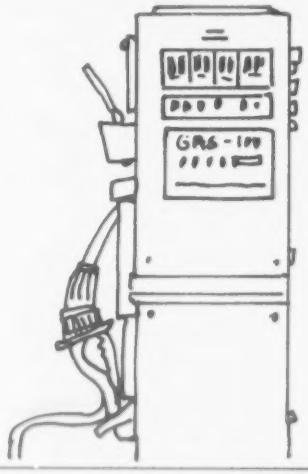
Energy At Work Puzzle

Name _____

Date _____

Match each worker with the correct occupation.
Draw a line from the worker to the correct occupation.

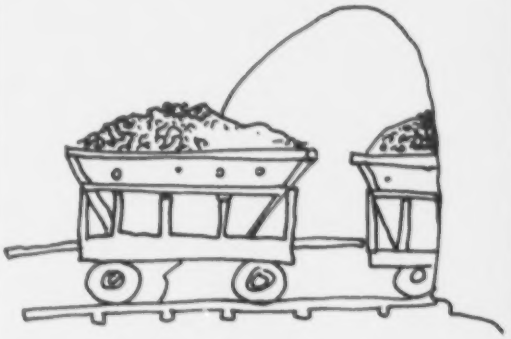


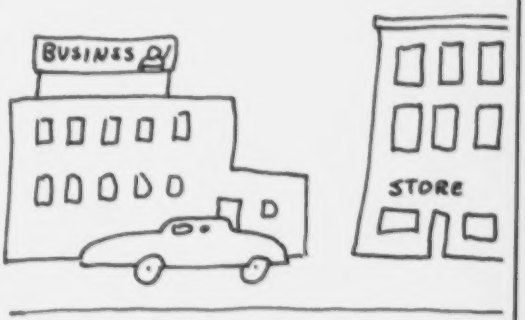


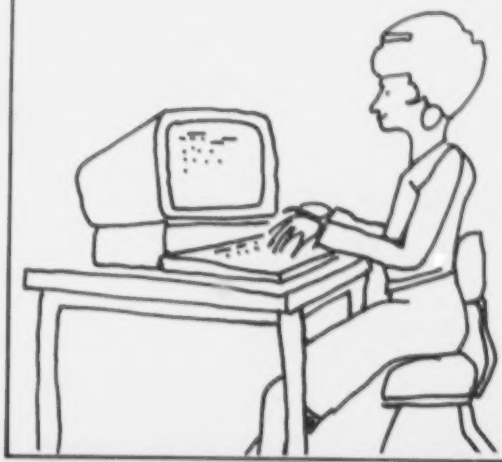
Energy At Work Puzzle

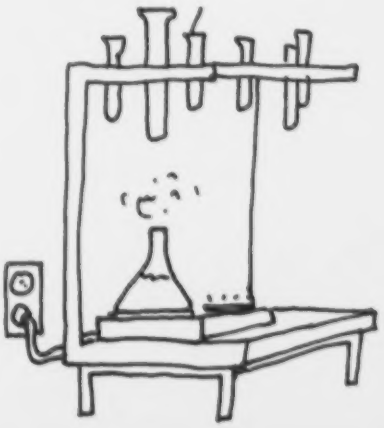
Name _____

Date _____









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Burning Releases Energy—and Waste

Activity 17

Science	Impacts	Grades 2-3	Time 45 min.

Concept

Energy resource development and use impact environmental conditions.

Activity Goal

Students will learn that the burning of fuels produces not only heat and light, but wastes too.

What You'll Need

- Candle
- Match

What To Do

1. Teacher demonstration: Burn a candle and/or a match and ask the students to make observations about what is produced. (Burning produces heat and light energy as well as waste in both solid and gaseous form.)

2. Explain that much of the energy we use every day comes from burning energy sources like coal and oil products (fossil fuels). Along with the heat and light produced - which we use to do things like make electricity and run cars - wastes are produced. (Students who have fireplaces and wood stoves will be familiar with this.)

3. Discuss with the students why it is important to keep these wastes from harming the air and water. Explain how energy conservation can help protect the environment.

Evaluation Idea

Have students name two ways energy conservation can protect the environment.

Notes: _____

Coal: More Than Meets The Eye!

Activity 18

Science, Mathematics	Limits	Grades 2-3	Time 60 min.

Concept

Energy resources are unevenly distributed

Activity Goal

Students will participate in a hands-on simulation to help them understand that coal resources are deposited unevenly between the earth's surface and under the ground.

What You'll Need

- Chocolate chip cookie for each student
- Napkin for each student
- Paper clip for each student
- Reference book containing map of U.S. coal deposits.

What To Do

1. Give each child a cookie and a napkin. Tell them not to eat it yet!

2. Tell the students that the cookie represents their country or state. The tan area of the cookie represents the earth's crust and the chocolate chips represent the coal deposits.

3. Instruct students to determine (count) how many visible chunks of coal are in their country. Students should count only the coal deposits visible from the top.

4. Record class data on the chalkboard.

5. Now have each student predict how many coal deposits they think they have in their country or state.

6. Provide each student with a paper clip and instruct them to begin "mining" their coal deposits. Have them place their coal deposits in one pile and the earth's crust in another.

7. Next, have students count the coal deposits. Record the class data on the chalkboard.

8. Compare and contrast the number of coal deposits visibly observed and actually in existence. How does the actual number of coal deposits compare to their predictions?

9. Discuss the following points with the class:

A. Our data tell us that there were more "coal deposits" than could be seen on the surface.

B. "Mining" the deeper coal took more time and was more trouble than mining coal near the surface. (It takes energy to get energy.)

C. "Mining" the coal has environmental impacts.

D. The coal deposits were unevenly distributed. Some students had more coal deposits than others.

10. Show the students a U.S. map of coal deposits which illustrates that some states have more coal deposits than others. Your school librarian should be able to assist you in locating a reference book with a map.

Evaluation Idea

1. What can you say about the distribution of energy sources?

2. True or false, it takes energy to obtain energy?

3. Can we use energy sources without affecting the environment?

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How Long Will It Last?

Activity 19

Science	Limits	Grades	Time
		K-3	5×30 min.

Concept

All energy resources have limits to their usefulness.

Activity Goal

The students will observe the depletion or limits of several common energy sources.

What You'll Need

- Flashlight with new general purpose D-cell batteries
- Small birthday candles
- Matches
- Sugar cubes
- Raisins

What To Do

1. **Flashlight energy:** Turn the flashlight on and leave it on until the energy is used up (12 - 36 hours). Have the students estimate or predict how long they think the energy in the batteries will last. Relate this investigation to the idea that the electrical energy in the batteries will last only a certain amount of time. The energy is limited.

2. **Candle energy:** Using a small birthday candle, have the students estimate how long the candle will burn, giving off heat and light energy. Again, relate this investigation to the idea that energy stored in the candle will last only a certain amount of time. The energy is limited. The energy in the candle is chemical energy from oil.

3. **Food energy:** Distribute sugar cubes to the class, one per student. Tell them they can eat them, but to conserve their sugar cubes as much as possible so they can last for a couple of days. At certain times during the day, have the students lick or nibble their cubes. Relate the activity to the fact that the food energy of the sugar is limited. It will last only so long.

4. Display a bowl of raisins in front of the room. Tell the students that they are going to experiment with the raisins by eating them, and that they must see if they can make the raisins last for several days. Explain to the students that the supply is limited. When the raisins are gone, they will not be replaced. Instruct the students by telling them that at any time they want a raisin to feel free to eat one. When the raisins have been depleted, discuss with the students what factors determine how long the supply lasts: size of class (population), use, alternative sources, amount of resource available.

5. Summary: Discuss the meaning of the word "limited," using the experiences the students have had with the activities. Relate "limited" to energy resources, such as coal, oil, and natural gas. Also discuss what a renewable resource is, e.g., wood, water, sun, wind. In what ways aren't they limited like nonrenewable resources? In what ways are they limited like nonrenewable resources?

Notes: _____

Now You're Cooking!

Activity 20

Science	Limits	Grades	Time
		2-3	60 min.

Concept

All energy resources have limits to their usefulness.

Activity Goal

Students will identify limits associated with energy sources.

What You'll Need

- "Now You're Cooking" worksheet for each student (or the worksheet questions can be used as a class discussion)
- Magnifying glass
- Birthday candle mounted on a plate
- Aluminum pie plate
- Watch with a second hand
- 2 sausages—each cut into six ½" pieces (hot dogs or mini marshmallows can be substituted for the sausage)
- 12 toothpicks

What To Do

(Conduct this activity on a warm, sunny day under close supervision by the teacher. Do not allow students to eat sausage cooked in this experiment!)

1. Review with the students the terms, "renewable" and "nonrenewable" energy sources. Tell the students they will be experimenting with using renewable and nonrenewable energy sources as they cook sausage.

2. Review the safety precautions students should be aware of when working with fire.

3. Give each student the worksheet, "Now You're Cooking."

4. Have students estimate the number of sausage pieces they think can be cooked using the candle, if each is cooked for about one minute (try it yourself first) and only one piece of sausage can be cooked at a time. Have the students record their guesses on the worksheet—question one.

5. Ask one student to be a timer and call time every minute.

6. Light the candle. Have students take turns holding a piece of sausage on a toothpick near the flame for one minute. Cook as many pieces of sausage as possible until the candle burns down.

7. Have the students answer questions two through eight on their worksheets. Discuss their answers as a class.

8. Repeat the experiment using the magnifying glass and the sun to cook the sausage. Have the students answer question nine on their worksheet. Demonstrate how a magnifying glass can be used to concentrate the sun's rays. (Warn the students about the dangers of looking directly at the sun, or of putting their hands under the magnifying glass). Have a student call time every minute.

9. Students can take turns cooking the sausage under the magnifying glass. Each piece should be cooked for one minute.

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10. Have the students answer questions 10 - 16 on the worksheet. Discuss the differences between cooking with the candle and cooking with the sun. Emphasize that both sources have limits. (Candle—nonrenewable, Sun—renewable, but requires cooking at a certain time of day and only if the weather cooperates)

Evaluation Ideas

Have students turn in their worksheets for your review.

Ask students to give examples of other sources of energy that have limits. Example: Wind—sailing a boat is limited by how much wind there is.

Have students summarize the pros and cons of using renewable and nonrenewab' resources.

Notes: _____

Now You're Cooking!

Name _____

Date _____

Using a candle

1. How many pieces do you think could be cooked by the candle?

2. How many pieces were cooked by the candle?

3. Did the results surprise you? Why or why not?

4. Can the candle be used again and again?

5. Do candles pollute the air?

6. Are candles quick to cook with?

7. Can you use candles to cook at any time of night or day?

8. Is the candle a renewable or nonrenewable source of energy?

Using the sun

9. How many pieces do you think could be cooked by the sun?

10. How many pieces were cooked by the sun?

11. Did the results surprise you? Why or why not?

12. Can the sun be used again and again?

13. Does the sun pollute the air?

14. Is the sun quick to cook with?

15. Can you use the sun to cook with at any time of day or night?

16. Is the sun a renewable or nonrenewable source of energy?

Pass The Sack

Activity 21

Science, Social Studies	Limits	Grades 2-3	Time 45 min.

Concept

Social decisions influence the availability of energy resources.

Activity Goal

The students will understand that some energy resources are nonrenewable and that their use is limited by social decisions.

What You'll Need

- Peanuts, cheerios, or other small pieces of candy—enough for 1½ times the class size.

What To Do

1. Count out enough candy so there is one piece per student. Put it in a paper sack. Save the remaining candy.

2. Before passing out the candy, review renewable and nonrenewable resources and give examples of each.

Renewable Resources

Wood
Water
Wind
Sun

Nonrenewable Resources

Coal
Oil
Natural gas

While this discussion is taking place, pass around the sack of candy, without any rules about how many pieces students can take. Occasionally add four or five pieces of candy to the sack. The sack will be empty before it reaches all the students.

3. Point out that fossil fuels have limits just like the candy. Emphasize that fossil fuels are nonrenewable and are being consumed faster than they are replaced in nature. Explain how much harder students would have to search the room to find the rest of the candy. What if the rules did not allow students to leave their desks? Point out that natural gas, coal and oil companies are looking harder for more resources. What affect did the availability of candy have on relationships between students? What affect might the availability of fossil fuels have on the relationships among nations, people, states, standard of living and quality of life?

4. With the class, now plan to pass out the remaining candy. Should rules be established? Do oil, coal, and natural gas companies have rules (regulations) that they must follow to find resources? Should there be rules and regulations on how much oil, coal or natural gas people use? How does the class's social decision influence the availability of candy?

5. Pass out the rest of the candy according to the plan.

Evaluation Idea

How might social decisions influence the amount of energy available to people? (Example: regulations on how much people use, or regulations on drilling or transportation of resources)

Astronaut Energy

Activity 22

Science, Mathematics, Social Studies	Future (?)	Grades 2-3	Time 45 min.

Concept

Different consumption practices may alter future demands on energy resources.

Activity Goal

Students will understand that the rate at which we use our resources affects the availability of the resource in the future.

What You'll Need

- 1 bag dried beans per team (containing exactly 15 beans per team member)
- 1 Space Menu Planner I per team
- 1 Space Menu Planner II per team

What To Do:

1. Divide the class into teams of two to four students each.

2. Set up the scenario: Explain that each group is the crew of a spaceship on a five-day voyage to the moon. And while their spacecrafts have more than enough fuel to get them to the moon and back—and everything they need to be comfortable on the voyage—the crews must now make some decisions about using their food energy resources while they're gone.

3. Pass out a bag of dried beans and one Space Menu Planner to each team. Explain that each bean represents one balanced meal for one astronaut. Then have each team decide how they'll spread their food resources (beans) over the five-day mission; to do this, the teams will distribute their beans on the Space Menu Planners.

4. Update the scenario: Blast off! The voyage begins...Involve students in describing their mission activities for each of the first four days. At the end of each day, collect the food energy resources (beans) consumed that day. As you begin Day 5 (before breakfast!), however, inform the astronaut teams that adjustments must be made to their landing gear and they can't return to earth for three more days! The teams' immediate task is to figure out how to make their food energy resources last for three days, instead of one.

5. Give each team Space Menu Planner II. Have the students use the Space Menu Planner to show how they will redistribute their food energy resources in light of the delay.

6. Ask the crews about their new menu plans. When they awoke on Day 5, they'd planned to eat everything they had left; did their plans change? If so, why? What if they'd gone ahead and eaten the food as they had originally planned? In the new plan, will the crew eat every day? Will everyone eat each day? As much, as often as in the first four days of the voyage? Is it important to have energy throughout the mission? Why? Looking back, would it have been a good idea to keep some food resources in reserve, just in case?

7. Bring the "spaceships" safely back to earth, then explain that when they planned how to use their limited resources and used them wisely (this was done **both** times they planned menus), they were practicing a kind of conservation. In the second case, conservation was more important, because there was a shortage of resources. Conservation can't make more of a resource (fifth day's food), but it can make it last longer.

8. Help students understand that most of the energy sources that make electricity and run our cars are limited, just like food was on the fifth day of their mission. By using our energy resources wisely and planning for their use, they too, can last a long time.

Evaluation Idea

Have the students place an "L" next to the energy sources which are "limited."

1. Coal
2. Oil
3. Sun
4. Wind
5. Wood
6. Running water
7. Natural gas

Answers:
Coal, oil, and natural gas

Notes: _____

Space Menu Planner I

Name _____

Date _____

Day	Breakfast	Lunch	Dinner
1			
2			
3			
4			
5			

Space Menu Planner II

Name _____

Date _____

Day	Breakfast	Lunch	Dinner
5			
6			
7			

Turn On To Switching Off!

Activity 23

Science, Art	Conservation	Grades K-1	Time 60 min.

Concept

There are various ways to conserve energy.

Activity Goal

The students will learn why energy conservation is important and learn several ways to save energy.

What You'll Need

- 3 x 4 inch piece of tagboard for each student
- crayons
- markers
- stickers, etc.

What To Do

1. Discuss with students the importance of everyone's helping to save energy. (saves money; conserves limited resources; reduces pollution)

2. Give students a few examples of ways they can save energy.

Next, see if they can correctly identify statements you read as practices that **save** energy or **waste** energy:

- Take showers instead of baths. (save)
- Turn lights off when they are not needed. (save)
- Leave the outside door open, letting the warm air out and the cold air in. (waste)
- Turn off TV or radio when nobody is watching or listening. (save)
- Open and close the refrigerator door quickly. (save)
- Wash dishes in the dishwasher after every meal or snack, even if it's not full. (waste)
- Put on a sweater when the room is cool, instead of asking someone to turn up the thermostat. (save)

3. A. Tell the students that sometimes we need reminders to help us save energy. Have students make covers for light switches to help remind them to turn the lights off.

B. Give each student a 3 x 4 inch piece of tagboard. Cut out the opening for light switch.

C. Have students decorate their "switch-off covers" with pens and stickers. Encourage creativity!

D. Allow students to display their switch-off covers by rotating a new cover for the classroom light switch each week. Students might also make covers for their light switches at home.

Evaluation Idea

Have students draw pictures showing ways they can conserve energy in their homes.

Notes: _____

Save or Waste?

Activity 24

Science, Language Arts	Conservation	Grades 2-3	Time 60 min.

Concept

There are various ways to conserve energy.

Activity Goal

The students will list three reasons to save energy. They will also identify activities that waste energy and practices that save energy.

What You'll Need

- Save or Waste? handout

What To Do

1. Tell the class that there are many things we can do at home to stop wasting energy. Give examples: It wastes energy to leave lights on in an empty room; it saves energy to turn off lights before leaving a room.

2. Cut apart the handout and "scramble up" the energy-related behavior statements.

3. Distribute the statements among your students. (Some students will receive two strips.) Challenge the students with "wasting" behaviors to find the students who have the "saving" behaviors that match the strips they hold, and vice versa.

4. Once the students have found partners with the correct cards, have each pair read their cards to the rest of the class.

5. Be sure the students understand how each corrective measure saves energy.

6. Ask the students what would happen if we didn't try to save energy. Lead them to understand that conservation extends energy resources, saves money, and protects the environment.

Evaluation Idea

Ask students to list three reasons why it is important to save energy and give an example of how they can conserve energy at home.

Notes: _____

_____

_____

_____

_____

Save or Waste?

It saves energy when you. . .	It wastes energy when you. . .
Use a pan the size of the burner on the stove.	Put a little pan on a big burner on the stove.
Cook many items in oven at the same time.	Cook only one item in oven.
Put lid on pan when cooking. It keeps heat in.	Leave lid off pan when cooking.
Keep oven door closed. Use a clock to tell when food is ready.	Peek in oven while food is cooking.
Toast bread in toaster, not in the oven.	Toast bread in oven, rather than in a toaster.
Stop cooking when food is tender.	Cook food longer than needed.
Run the washing machine with a full load.	Run the washing machine without many clothes in it.
Wash clothes in cold water when possible.	Wash clothes with more hot water than needed.
Take a shower, instead of a bath.	Fill bath tub to the top.
Wash and rinse dishes in two pans.	Wash dishes under a running faucet.
Fix the leaking faucet.	Have a leaking faucet.
Iron clothes all at the same time.	Iron clothes one or two items at a time.

Turn off TV or radio when nobody is watching or listening.	The TV or radio plays to an empty room.
Turn off lights that you don't need.	Lights are on in empty room.
Close the curtains in the room you're cooling.	The sun shines into the room you're trying to cool.
Open and close the refrigerator door quickly.	You keep the refrigerator door open longer than needed.
When it is cold, wear warm clothes in several layers.	When it is cold, wear thin clothes.
When it is cold, close outside doors quickly.	When it is cold, leave outside door open longer than needed.
Stuff rags, paper or rug in crack under outside doors.	Have a crack under the outside door.
Have good insulation in outside walls and roof.	Have poor insulation in outside walls and roof.
Combine errands so that only one trip in the car is needed.	Take many trips in the car.

Save Energy With Power Bear

Activity 25

Science, Art	Conservation	Grades K-3	Time 60 min.

Concept

There are various ways to conserve energy.

Activity Goal

The students will learn five ways they can save energy.

What You'll Need

- Copy of coloring book for each student
- Crayons

What To Do

1. Give each student a copy of the coloring book.
2. Read each page of the coloring book as a class. Explain why it is important to help conserve energy.
3. Have students color the pages.

Evaluation Ideas

1. Have the students draw pictures showing ways they can conserve energy in their homes.
2. Have the students ask their parents about energy saving practices used in their homes. Hold a sharing session to discuss their findings.

Notes: _____

_____

_____

_____

_____

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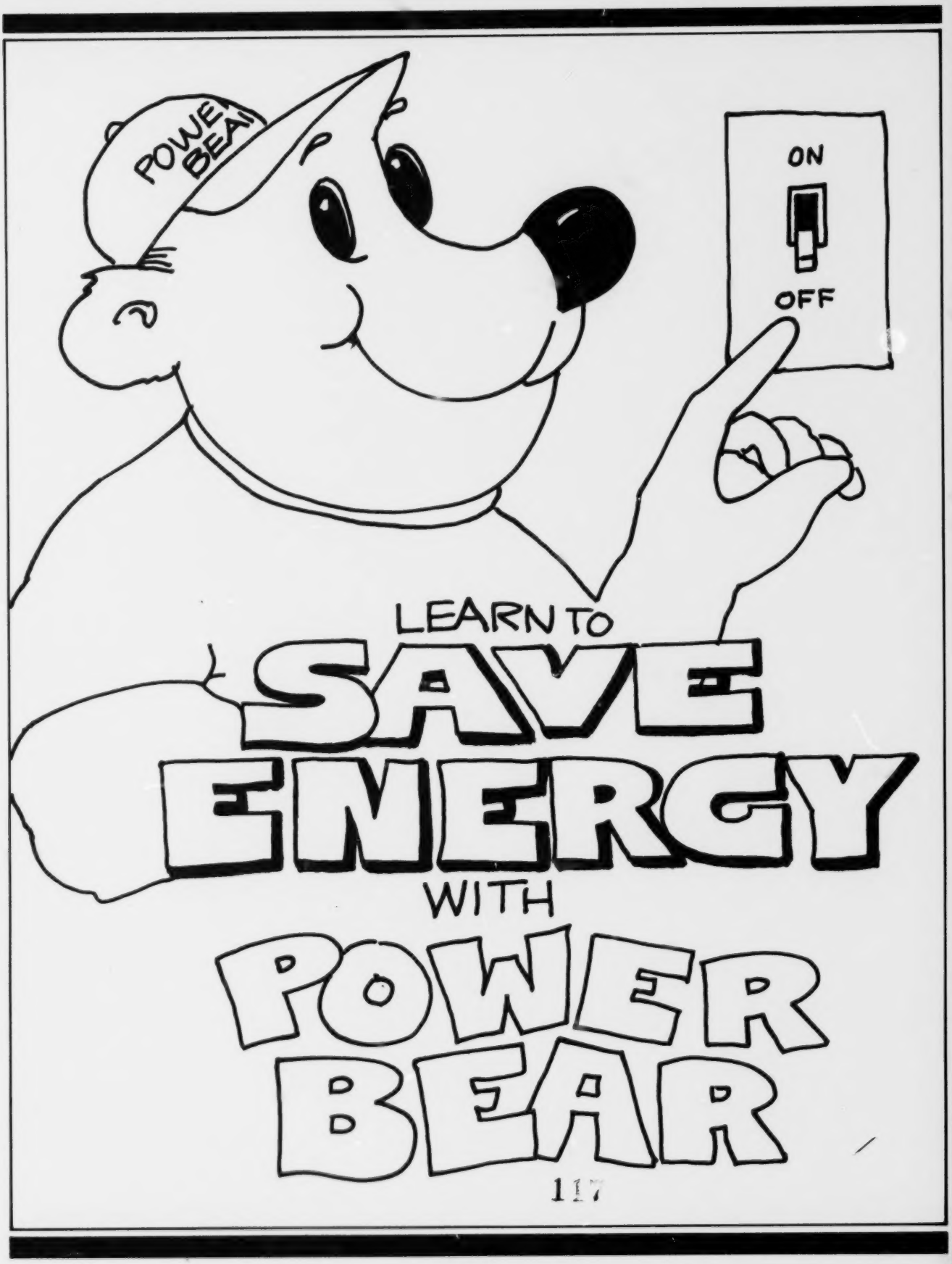

POWER BEAR
ON
OFF
LEARN TO
SAVE
ENERGY
WITH
POWER
BEAR
117

ELECTRICITY
IS ENERGY WE USE EVERY DAY.
IT HELPS US DO THINGS MORE EASILY!
POWER BEAR
POWER BEAR

WE USE THESE SOURCES TO MAKE ELECTRICITY

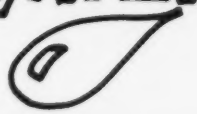
1 COAL

2 OIL

3 NATURAL GAS

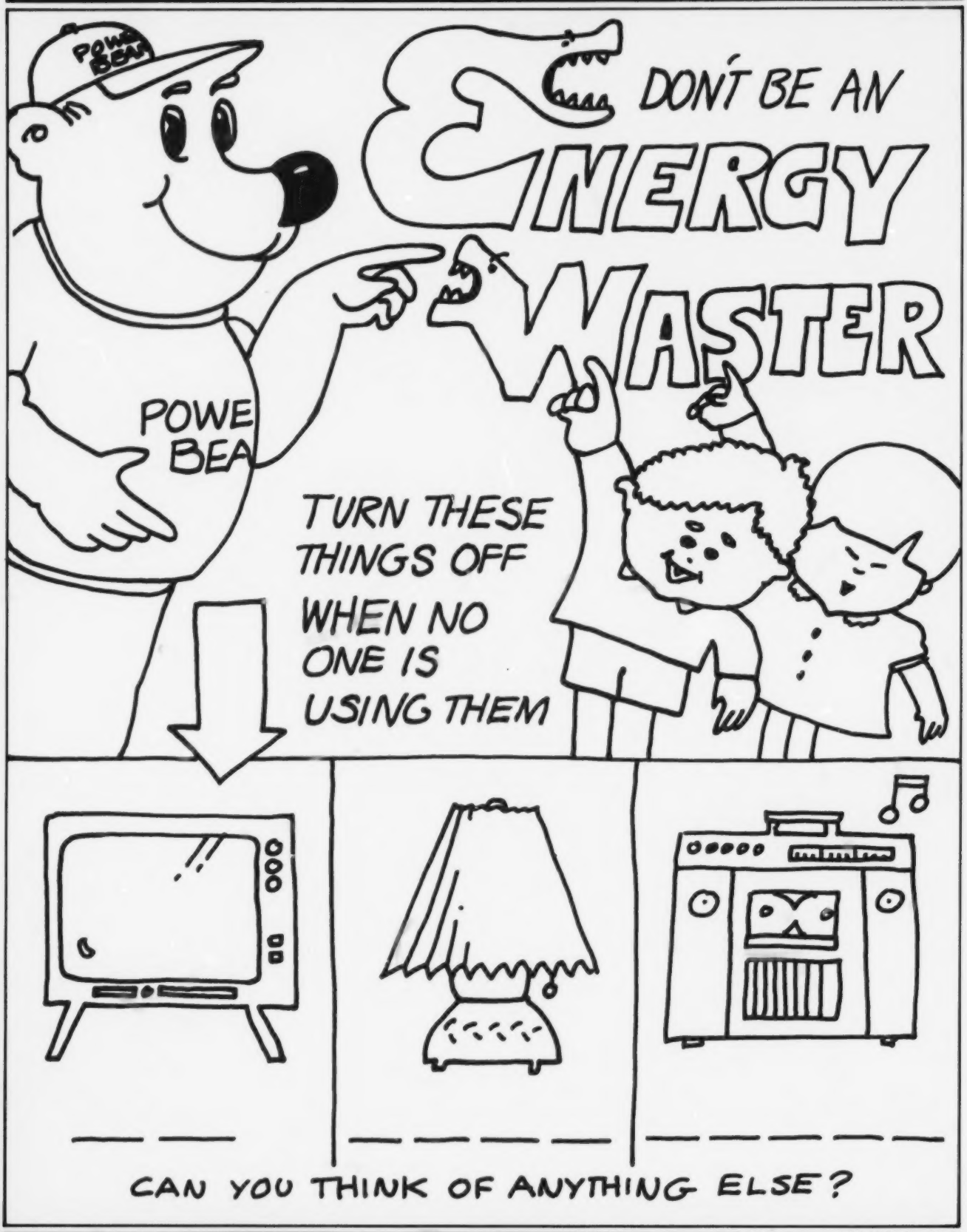
4 ATOMS (NUCLEAR)

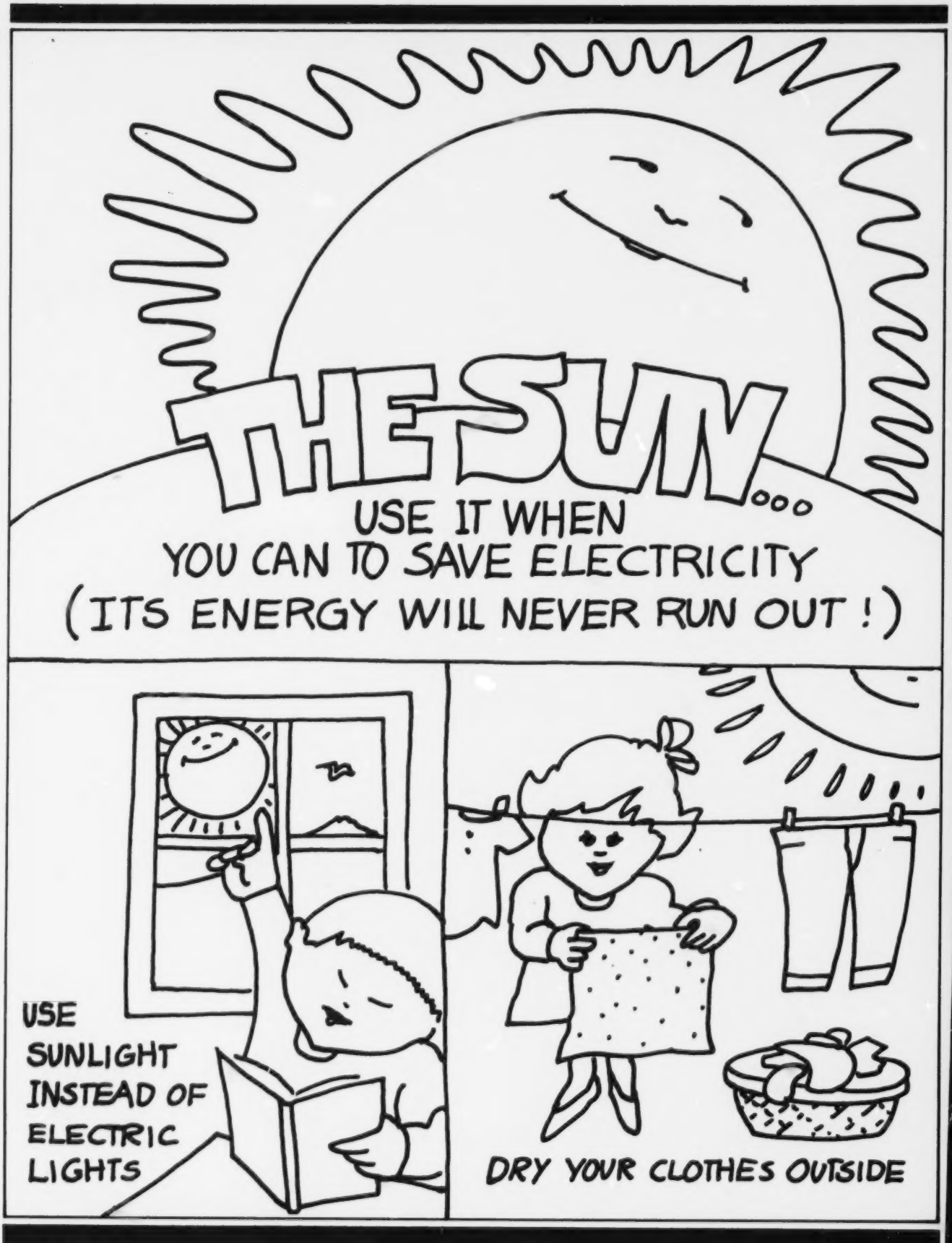
5 FALLING WATER



LEARN TO SAVE ENERGY

SO IT WILL LAST A L-O-N-G TIME!


DONT BE AN
ENERGY
WASTER
POWE
BEA
TURN THESE
THINGS OFF
WHEN NO
ONE IS
USING THEM
CAN YOU THINK OF ANYTHING ELSE?


THE SUN...
USE IT WHEN
YOU CAN TO SAVE ELECTRICITY
(ITS ENERGY WILL NEVER RUN OUT!)
USE SUNLIGHT INSTEAD OF ELECTRIC LIGHTS
DRY YOUR CLOTHES OUTSIDE

IN THE
WINTER
WEAR WARM CLOTHES INSIDE THE HOUSE
(This lets mom or dad turn the heat down!)
Shut this door tight! Thanks
POW BEA
Remember...
SHUT THE DOOR TIGHT TO KEEP THE HEAT IN
AND THE COLD AIR OUT.

SHUT THE CURTAINS
IN THE SUMMER TO KEEP THE SUN'S HEAT OUTSIDE.
WEAR SHORTS AND TOPS MADE OF LIGHT COLORS...
TO KEEP YOU COOL!
POWER BEAR

NOW...
HELP POWER BEAR
LOOK FOR MORE WAYS TO
SAVE ENERGY.....
AROUND
YOUR
HOUSE!

Be An Energy Saver!

Activity 26

Science	Conservation	Grades	Time
		2-3	2×45 min.

Concept

There are various ways to conserve energy.

Activity Goal

Students will identify ways they can conserve energy at home.

What You'll Need

- Hot Plate
- Saucepan (one with a lid)
- Liquid Measuring Cup
- Watch
- Water
- Paper
- Crayons
- Copy of "Energy Saving Tips" for each student

What To Do

1. Ask students if they think there would be any difference between boiling water in a covered pan and boiling water in a pan without a lid. Why or why not? What differences might there be? List their responses on the chalkboard. Examples: faster boiling with lid; hotter water with lid; more evaporation without lid.

2. Teacher demonstration:

A. Turn on hot plate. Add two cups water to a saucepan. Do not use a lid. Once the hot plate is hot, put the saucepan on it. Have students time how long it takes for the water to boil vigorously. Record the time it takes.

B. Allow the saucepan to cool. Add two cups of water to the saucepan and cover the pan with a lid. Put saucepan on hot plate once it is hot. Have students time how long it takes for the water to boil vigorously. Record the time it takes.

3. Ask: Did covering the pan save energy? Why?

4. Ask students to think of other ways to save energy and make a list on the chalkboard. Using "Energy Saving Tips," discuss with students how these practices help conserve energy and how **they** can help conserve energy in their homes.

Evaluation Idea

Have the students draw pictures of all the ways they use energy while getting ready for school in the morning. Then have them list ways they can conserve energy while getting ready for school.

Notes: _____

_____

_____

_____

_____

_____

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Energy Saving Tips

Name _____

Date _____

_____ Take quick showers rather than tub baths.

_____ Turn off lights in unoccupied rooms.

_____ Turn off the TV when no one is watching it.

_____ Open the refrigerator and freezer as little as possible, and only for a short period of time.

_____ Walk, car pool or take the bus to school, if possible.

_____ Use a sink stopper or dishpan rather than washing and rinsing dishes under running water.

_____ Use the dishwasher only when fully loaded.

_____ Avoid opening the oven door while cooking.

_____ Make sure water faucets don't drip.

_____ Boil water in covered pans.

_____ Match the size of the pan to the heating element.

_____ Wash clothes in warm water or cold water; rinse in cold.

_____ Walk or ride a bicycle, rather than drive the car, whenever possible.

_____ Close the chimney damper when the fireplace is not being used.

_____ In the winter, set the thermostat at 65 degrees. If the thermostat controls the air conditioning, in the summer set the thermostat at 78 degrees.

_____ In the winter, keep draperies and shades open in sunny windows; close them at night. In the summer, close curtains when the sun is shining directly in the windows.

_____ Install storm windows and doors.

Keep It Cool!

Activity 27

Science	Conservation	Grades 2-3	Time 2×45 min.

Concept

There are various ways to conserve energy.

Activity Goal

The students will identify materials that can be used for insulation and describe how the materials help save energy.

What You'll Need

- Ice cube for each student
- A variety of insulation materials (wool, cotton, foam)
- Sample containers (boxes and jars; do not allow manufactured coolers or thermoses.)
- Conservation badge for each student

What To Do

1. Introduce the activity by explaining that a lot of energy is used to keep hot things hot and cold things cold. Ask for examples. (Keeping cooked foods hot; keeping frozen foods cold; keeping our homes cool in the summer; keeping our homes warm in the winter.)

2. Explain that certain materials are very useful for keeping things at temperatures we like. They're found in thermoses and coolers, the walls and roofs of our homes, and in our winter coats. And the thing that almost all of these insulators have in common is in their use of air space as a barrier to heat exchange. Show and discuss examples of insulation materials.

3. Challenge the class to think of ways they could keep an ice cube from melting—an activity they'll be trying the next day. Have students bring insulating materials from home. Encourage creativity and parental involvement!

4. The next day, allow time for students to organize and assemble their materials.

5. Give one ice cube to each student. Remind the class that the challenge is to make their ice cubes last as long as possible.

6. Check the ice cubes every 10 to 15 minutes to determine how long the ice cubes last.

7. Once all of the ice cubes have melted, award a conservation badge to all participants. (See sample conservation badge)

Evaluation Idea

Ask students to list three materials that could be used effectively as insulation, and describe how the materials help conserve energy.

Notes: _____

_____

_____

_____

_____

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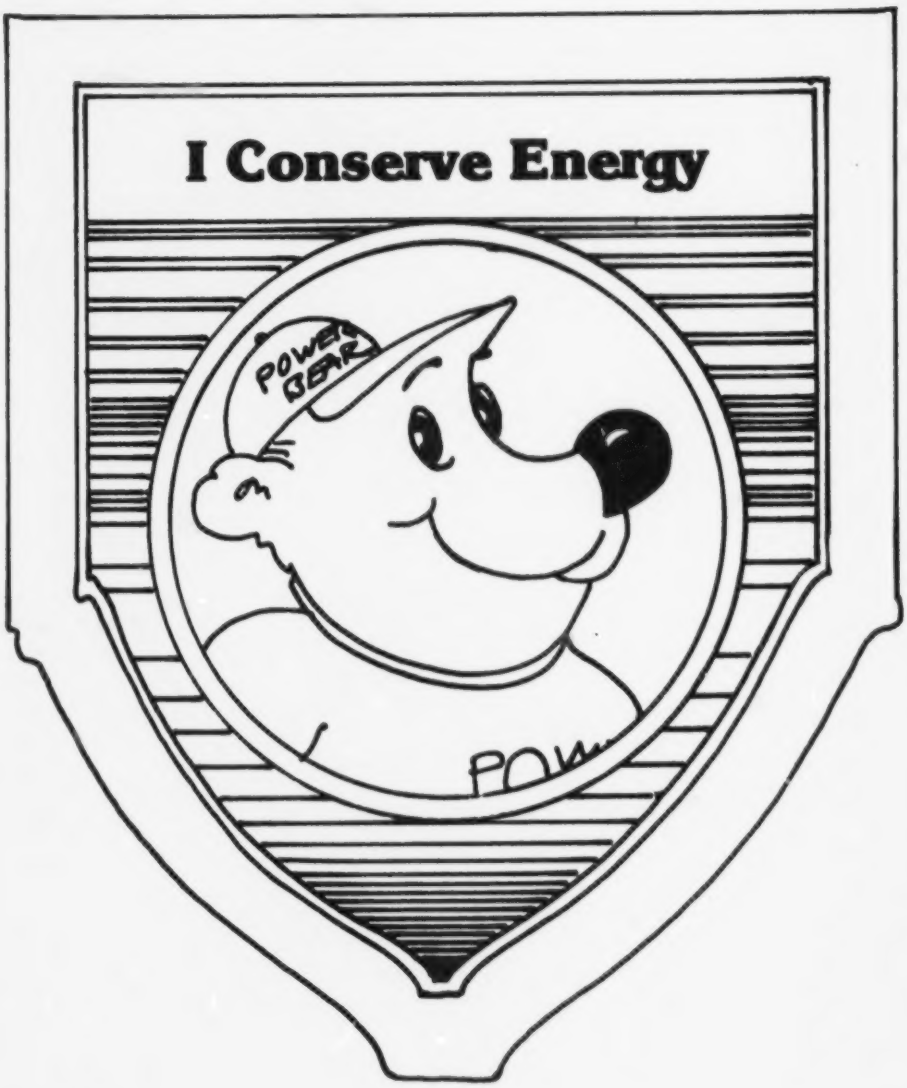
Name _____ Date _____



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The Best Color

Activity 28

Science, Art, Mathematics	Conservation	Grades 2-3	Time 60 min.

Concept

There are various ways to conserve energy.

Activity Goal

The students will explain that the color of paint can affect the absorption of heat energy.

What You'll Need

- Cans—a minimum of four
- Poster paint—flat, not glossy (white, black, red, green)
- Hot water
- Thermometers
- Plastic wrap
- Rubber bands
- Student Data sheets

What To Do

1. Divide the class into groups of four. Each group will paint four cans: one white, one black, one green, and one red. Give each group a data sheet.

2. Have each group fill its cans with the same amount and temperature of water. The water should be cold. Put a thermometer in each can and cover top with plastic wrap fastened to the can with a rubber band. The cans should then be placed in the sun. Record the temperature every five minutes for 30 minutes. Make a data table on the chalkboard (similar to the one shown below) on which to record each group's results. Make a bar graph on the chalkboard to illustrate the students' data (average). Repeat using hot water.

time (minutes)	white	black	red	green
30				
25				
20				
15				
10				
5				

temperature

3. Following the experiment, ask students which colors would be best for painting homes, schools and other buildings to keep them warm in winter. Which color clothes would be warmer in the winter? Cooler in the summer? How can choosing the best color save energy?

Evaluation Idea

Ask students the following questions:

1. On a warm summer day, what color clothes would you wear to stay cool?

2. What color house would be warmer in the winter - red, white, black, green?

Answers

1. White 2. Black

Notes:

Student Data Sheet

Name _____
Date _____

Using Cold Water

Temperature

Time	white	black	red	green
5 min.				
10 min.				
15 min.				
20 min.				
25 min.				
30 min.				

Using Hot Water

Temperature

Time	white	black	red	green
5 min.				
10 min.				
15 min.				
20 min.				
25 min.				
30 min.				

Eagle Eye, The Energy Waste Spotter

Activity 29

Science	Conservation	Grades	Time
		K-1	30 min.

Concept

There are various ways to conserve energy.

Activity Goal

The students will identify ways to recycle and conserve resources.

What You'll Need

- Picture or drawing of an eagle (included)
- Chart to record findings
- Eagle Eye award feathers for each student
- Conservation badges for each student

What To Do

1. Display a picture of an eagle, and discuss his excellent vision. Eagles have much keener sight than humans. Tell the students that this eagle is called Eagle Eye, The Energy Waste Spotter. Eagle Eye can't stand to see our energy wasted. Whenever he sees waste, he stops it and suggests better ways to use energy.

2. Discuss with students some of the energy wastes Eagle Eye might see. Ask the class for suggestions. Responses might include open exterior doors, leaving lights on, partly used notebook paper, piles of "garbage" that might have other uses.

3. Have the students pretend to be Eagle Eye and that they are to find energy waste and report it to you. Record their findings on a chart with two columns: (1) Energy Wasted (2) A Better Way. As children have their findings recorded, recognize them by presenting Eagle Eye feathers. Make the feathers of tagboard, cardboard, or cereal boxes.

4. After several days of Eagle Eye role-playing, help the students draw conclusions about their findings.

5. Give each student a conservation badge to color and wear home.

Career Awareness Idea

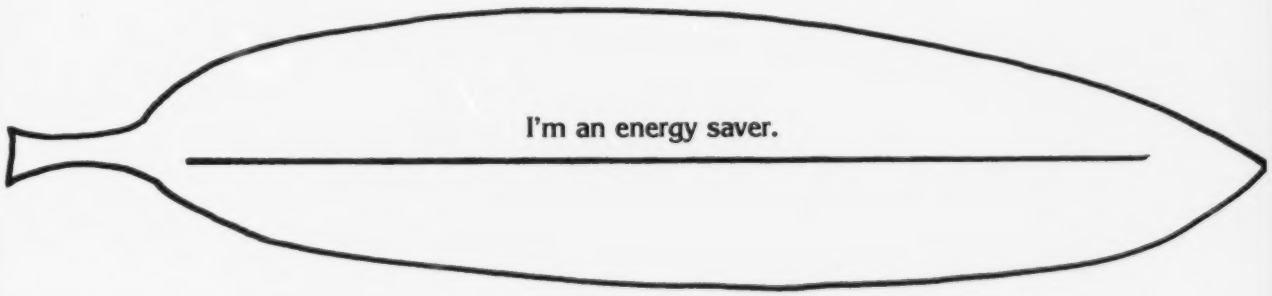
Ask the students what people have jobs that help Eagle Eye prevent energy waste. (Examples: bus driver, architect, home economist, home builder)

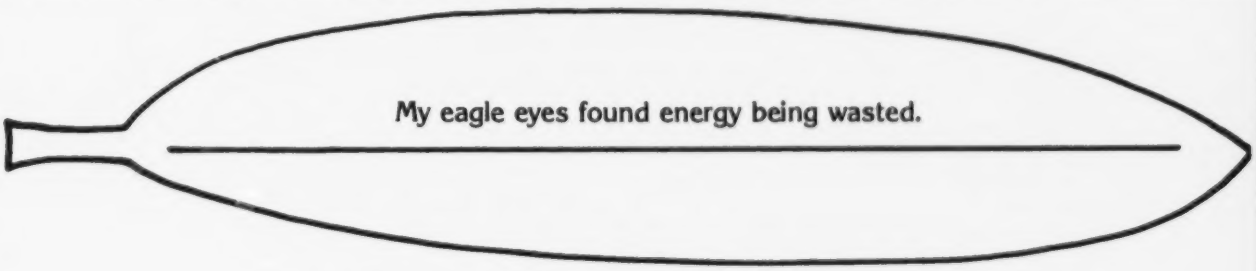
Evaluation Idea

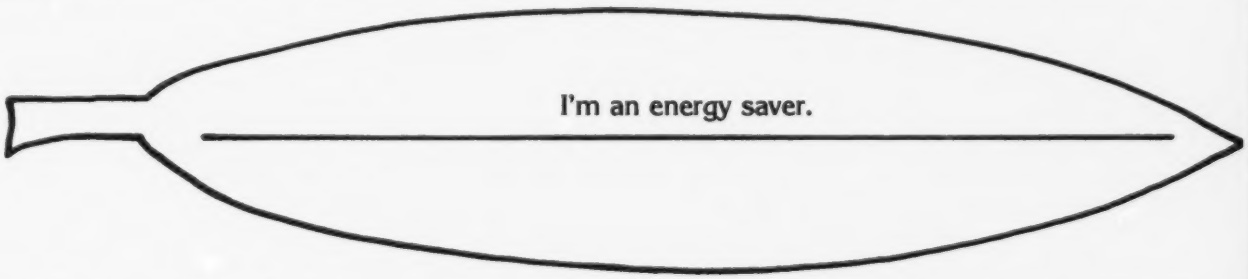
Have each student verbally suggest one way to conserve energy.

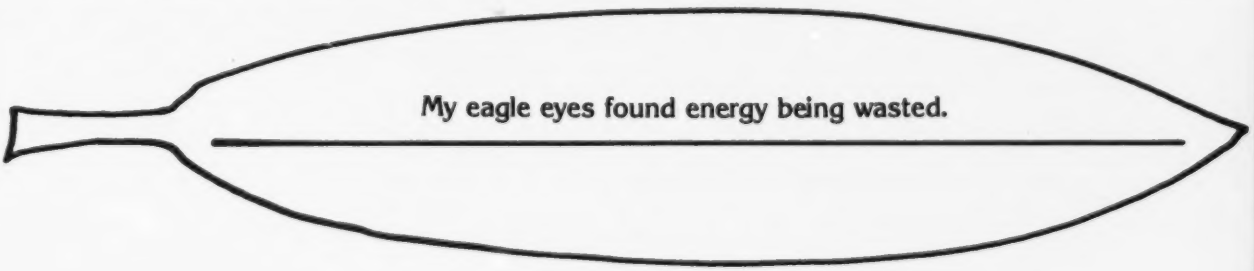
Eagle Eye, The Energy Waste Spotter

Eagle Eye Award Feathers









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Conservation Badge

Name _____

Date _____

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Helping Hands

Activity 30

Science, Art, Language Arts	Conservation	Grades 2-3	Time 5×30 min.

Concept

There are various ways to conserve energy.

Activity Goal

The students will state one method of conserving natural gas, coal, food, wood, sun, electricity, oil, and water.

What You'll Need

- Student handouts, cut by teacher to make a booklet
- Stapler
- Blank paper
- Construction paper for "Helping Hands"
- Felt markers or crayons
- Large symbols (or magazine pictures) of each energy source for bulletin board

What To Do

1. Tell the students they will play a guessing game. Pass out pages 1 and 2 of booklet.

2. Read page 1. Students can take turns reading aloud. They can then guess what the energy source is and write its name in the "I am" box.

3. Discuss the questions asked before drawing the picture. Before students begin illustrating, discuss ways you could draw gas, oil, and water. You may wish to suggest ways to represent these ahead of time. Once discussion has ended, have the students draw.

4. Follow the same procedure for the remaining pages.

5. When students have finished all the pages, staple them together to make a booklet. Put a blank sheet on the front which students can decorate. The title can be, "What Am I?"

6. Remind the students that as each page was completed they discussed how they could help the source last longer to help more people. Ask them to keep the discussions in mind for the next step.

7. Have the students trace one hand on a piece of construction paper. Each student should pick an energy source that he or she would like to help conserve. On the hand, have the student write how he or she could help. For example, if the source chosen is oil, the student could make fewer trips to the store or walk to a friend's house. Use markers or crayons so that writing will show up. Cut out hands.

8. Put pictures of energy sources on bulletin board, and title it "Helping Hands." Have each student put his hand next to the energy picture he is helping to conserve.

9. Discuss students' "Helping Hands."

Career Awareness Idea

Survey the class to see how many parents work in a job directly related to these energy sources.

Evaluation Idea

Have students list one way to conserve energy for four energy sources or forms of energy.

Helping Hands

Name _____

Date _____

(1)
I am used in cars.
I am a liquid.
I come from crude oil.
People pump me through a hose.
Cars and trucks need me to run.
People use too much of me.
How could I last longer to help
more people?

I AM _____

DRAW A PICTURE OF ME.

(2)
I am black and shiny and hard.
I am burned for heat.
People mine for me deep in the ground.
I am very old!
I come from ancient plants.
How could I last longer to help
more people?

I AM _____

DRAW A PICTURE OF ME.

Helping Hands

(3)
You like me!
I give you energy.
You can find me in a grocery store.
You need me to grow.
What can be done to be sure there will be plenty of me for everyone?

I AM _____

DRAW A PICTURE OF ME.

(4)
I am so important!
I am used for many things.
People burn me in a fireplace to keep them warm.
I make lovely furniture, and I am used to build houses.
What can be done to be sure there will be plenty of me for everyone?

I AM _____

DRAW A PICTURE OF ME.

Helping Hands

(5)
I give heat and light.
I make the day warm.
I help plants grow.
Please think of more ways that people could use my energy.

I AM _____

DRAW A PICTURE OF ME.

(6)
Light bulbs need me.
Without me, computers will not work.
I am a "powerful" thing!
I am a form of energy.
I am made by the burning of coal, oil, or natural gas.
Can you think of more ways people could use my energy?

I AM _____

DRAW A PICTURE OF ME.

Helping Hands

(7)
Gasoline is made from me.
Some people use me to heat their homes.
I can help fix a squeaky door.
How can I last longer to help more people?

I AM _____

DRAW A PICTURE OF ME.

(8)
I am very wet.
People channel my energy through dams so I can make electricity.
I am good to drink.
I cool you in summer and help keep you clean.
In what other ways do people use my energy?

I AM _____

DRAW A PICTURE OF ME.

Helping Hands

(9)
I heat homes and water.
I am not a solid.
I move through pipes.
I cannot be seen.
I am made smelly for your safety.
How can you use me more wisely?

I AM _____

DRAW A PICTURE OF ME.

(10)
Energy from inside me is sometimes used to make electricity.
I am split to make heat.
I am very tiny—invisible to the human eye.

I AM _____

DRAW A PICTURE OF ME.

Create A Commercial!

Activity 31

Language Arts, Science, Art	Conservation	Grades 2-3	Time 4×30 min.

Concept

There are various ways to conserve energy.

Activity Goal

The students will create a commercial to encourage reduction of energy waste.

What You'll Need

- Paper
- Felt tip pens

What To Do

1. Tell the class that in small groups they will be given the opportunity to write commercials that will encourage people to reduce their waste of energy. Student advertisements might be for T.V., radio, or the print media.

2. Have the class chart examples of each type of energy waste. (Examples: lights are on in an empty room; have a leaking faucet; wash dishes under a running faucet; fill bath tub to the top; peek in oven while food is cooking.)

3. Prepare a commercial or write a jingle together as a class first to give students some ideas for format.

4. Let students divide into groups of four.

5. Give each group a paper and pen. Tell them to discuss and then record ideas for their commercials.

6. Once the students' ideas are established, allow time for them to create a commercial format.

7. Encourage the students to practice and prepare to present their commercials for the rest of the class and perhaps to other classrooms.

8. Have students present their commercials. Perhaps students can read jingles over the public address system.

Optional Activity

Have a parent with a video recorder record student commercials

Career Awareness Idea

Invite someone from a local advertising agency to talk about his or her job and about creating advertisements.

Evaluation Idea

List four ways people can change energy-wasting habits.

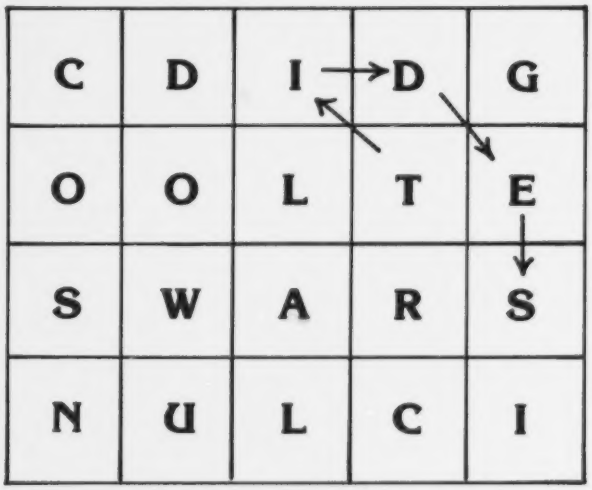
Notes: _____

Just For Fun Activities

ENERGY SOURCE SEARCH

Name _____

Date _____



Five energy sources are hidden in this puzzle. In order to find them, place your finger in any box and move it from box to box so that an energy source is spelled without lifting your finger. You may not enter the same square twice in one word. You may move up, down, diagonally in any order. One energy source is done for you. That source is "tides." Can you find five?

1. _____ 4. _____

2. _____ 5. _____

3. _____

Now try making your own puzzle. Use other sources or uses of energy.

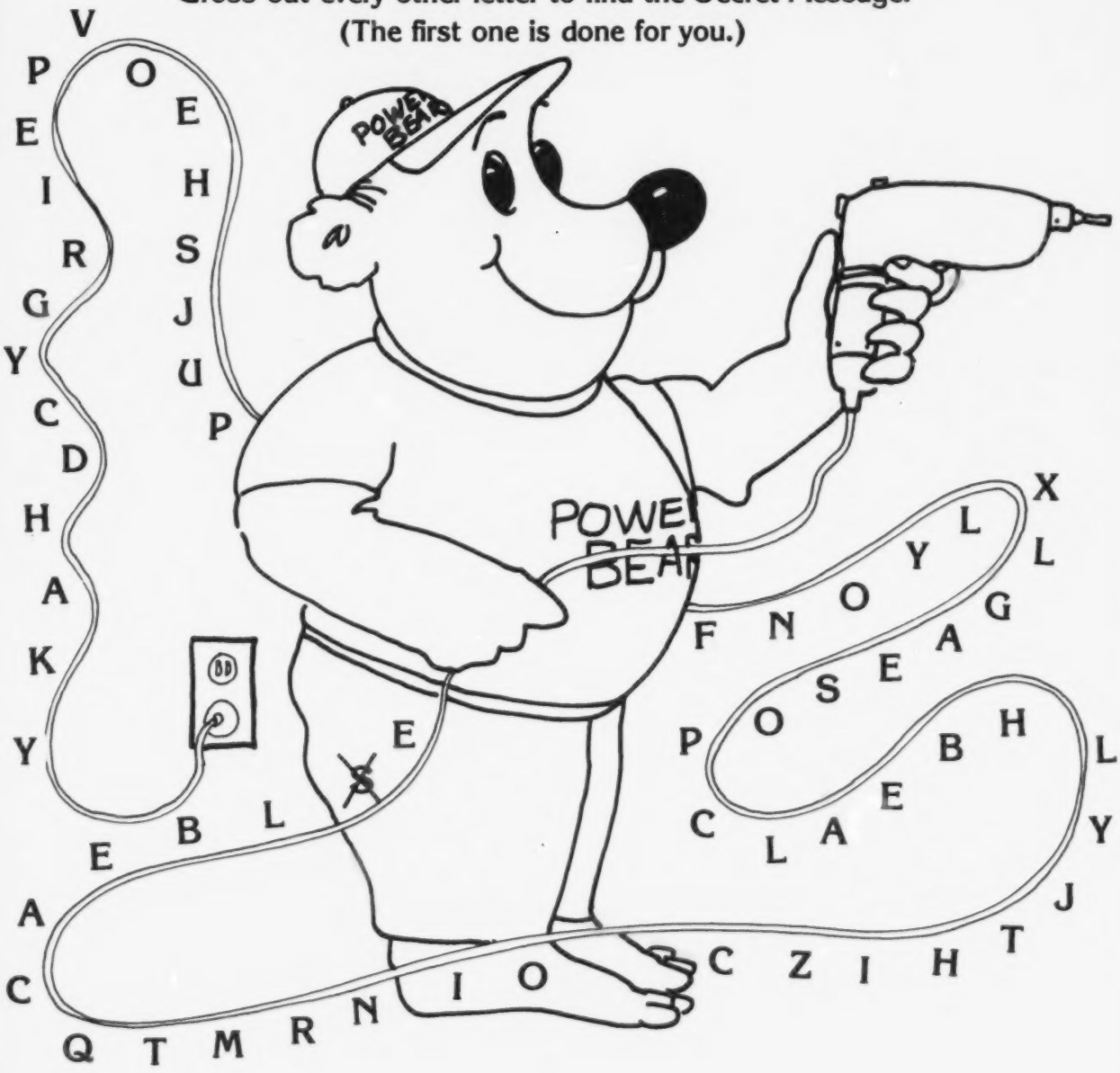
Share it with a friend.

SECRET CROSSOUT

Name _____

Date _____

Cross out every other letter to find the Secret Message.
(The first one is done for you.)



_ _ _ _

CIRCUIT CONSTRUCTION

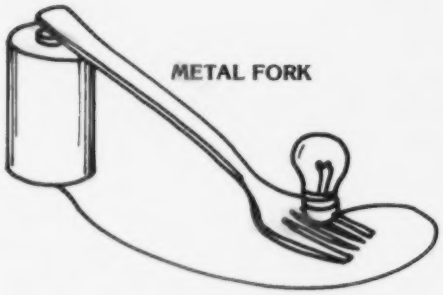
Name _____

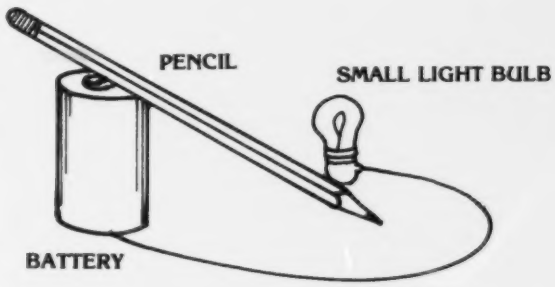
Date _____

Using a general purpose battery, a flashlight bulb, and a piece of insulated wire stripped at both ends, make a circuit tester. Check to see which items listed below will close the circuit and make the bulb light and which won't.

wood pencil	the leg of your chair	tack
plastic spoon	your notebook	chair seat
metal spoon	chalk	your finger
your desk top	crayon	pin

WILL CLOSE THE CIRCUIT	WON'T CLOSE THE CIRCUIT
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____





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CONSERVATION WORD SCRAMBLE

Name _____

Date _____

Unscramble the following words by using the conservation clues which are given.

_ _ _ _ _ KEBI	Use when going short distances, help save gasoline.
_ _ _ _ _ EVON	Keep door closed, don't keep peeking. Use a clock to tell when food is ready.
_ _ _ _ _ _ DORIA	Turn off when no one is listening to it.
_ _ _ _ _ _ RDERY	Use a full load - but don't overload.
_ _ _ _ _ _ RODOS	When going in and out, don't leave outside ones open.
_ _ _ _ _ _ _ UFCATE	If leaking, be sure to fix it.
_ _ _ _ _ _ _ REFEZRE	Defrost this regularly to save energy.
_ _ _ _ _ _ _ ROWSHE	Take this instead of a bath, keep it short.
_ _ _ _ _ _ _ _ _ _ TINISLUANO	Make sure you have this in outside walls and roof.
_ _ _ _ _ _ _ _ _ _ WSIRHEDSAH	Use it only for a full load.
_ _ _ _ _ _ _ _ _ _ OTMATHSETR	Turn it back to 60 degrees at night or when no one is home.
_ _ _ _ _ _ _ _ _ _ RAFIORREGRTE	Open and close this door quickly.
_ _ _ _ _ _ _ _ _ VENSITLEIO	Turn off when no one is watching it.
_ _ _ _ _ _ GTLSIH	Turn off when room is not is use.

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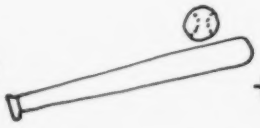
CONSERVATION PICTURE PUZZLE

Name _____

Date _____

1 Take quick +s instead of  +hs.

_____

2 off +s that don't +d.

_____

3 Put on when coo+ .

_____

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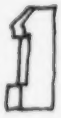
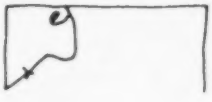
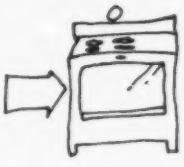
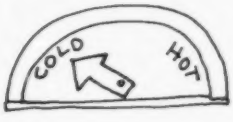
4 Turn

 when no+  is +ing it.

5 Re+ lea+ +s.

6 Don't  in  .

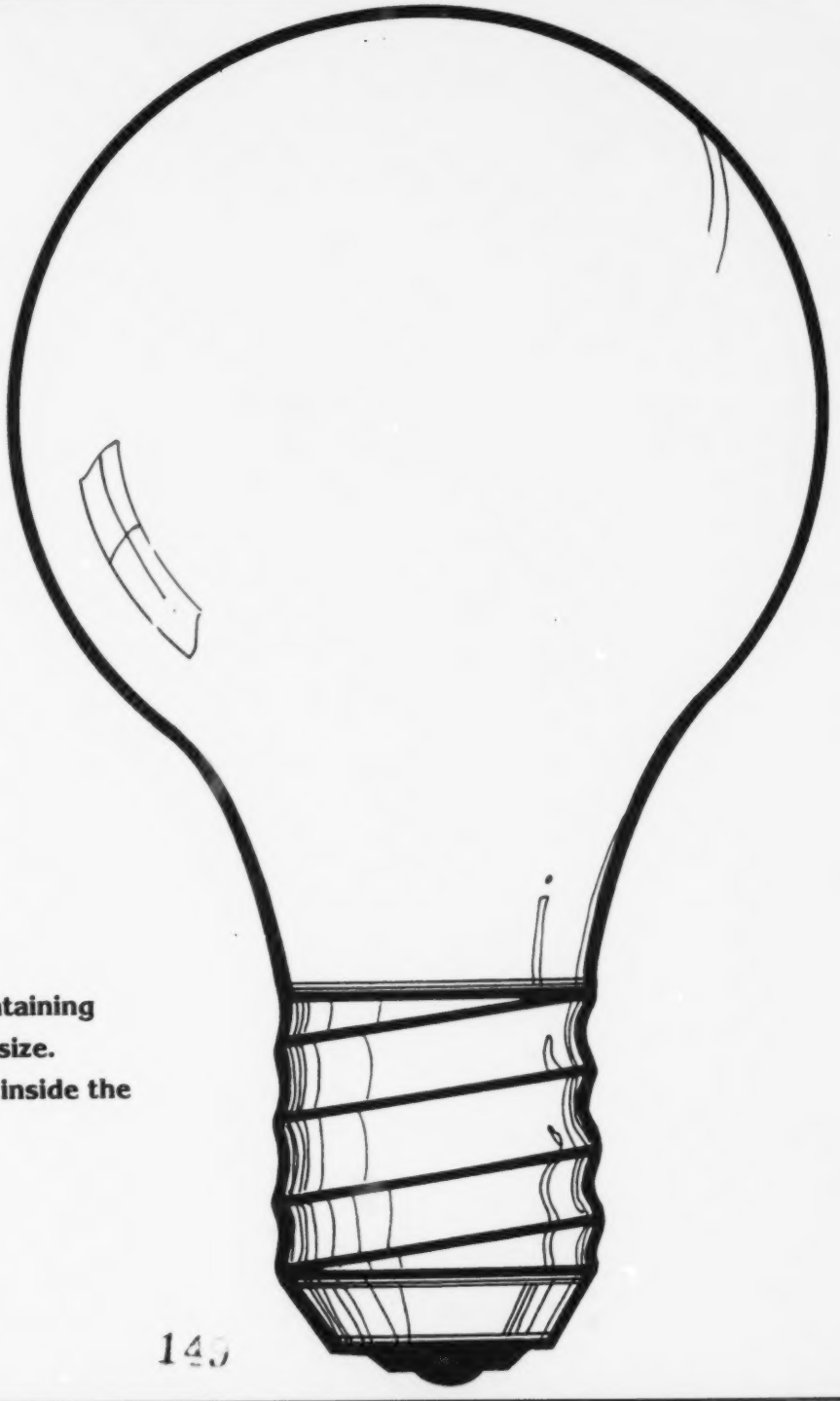
7 Wash in 

water.

LET THERE BE LIGHT!

Name _____

Date _____



Think of items containing light bulbs of any size. List or draw them inside the bulb.

BE AN ENERGY WORD DETECTIVE

Name _____

Date _____

1. SGA _____

2. ILO _____

3. NREGYE _____

4. LCAO _____

5. USN _____

6. VERCNSANOITO _____

7. NWDI _____

8. LSORA _____

9. OODW _____

10. ODOF _____

Now alphabetize the energy words:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

On the back, draw a picture showing an example of the third word in your alphabetical word list.

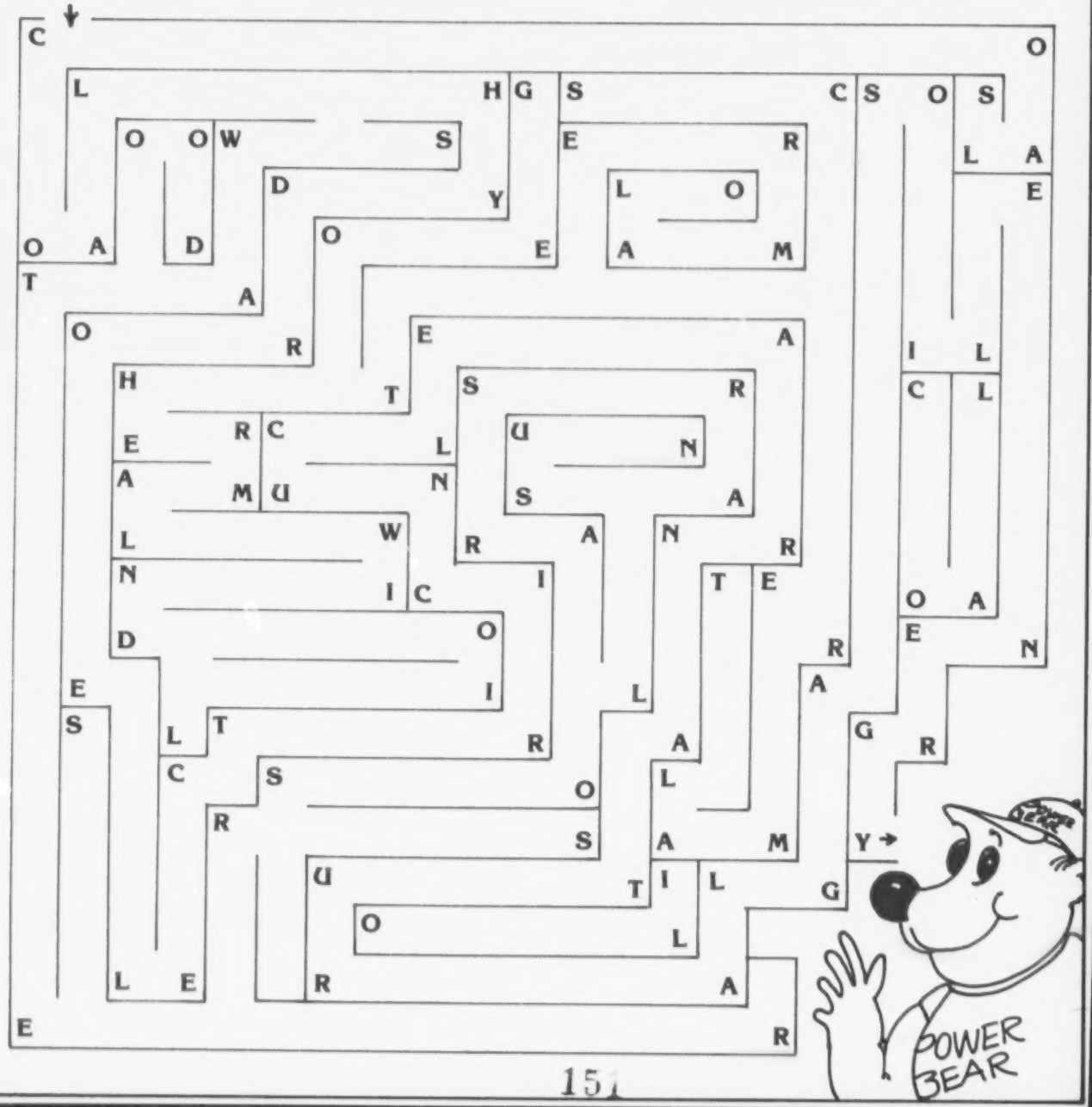
150

FIVE PRIMARY ENERGY SOURCES

Name _____

Date _____

Find your way through the maze and in doing so you will discover the names of the five primary energy sources. As you pass a letter, write it down on the back of this paper. When you have reached the end, look at the letters and decide what words have been spelled.



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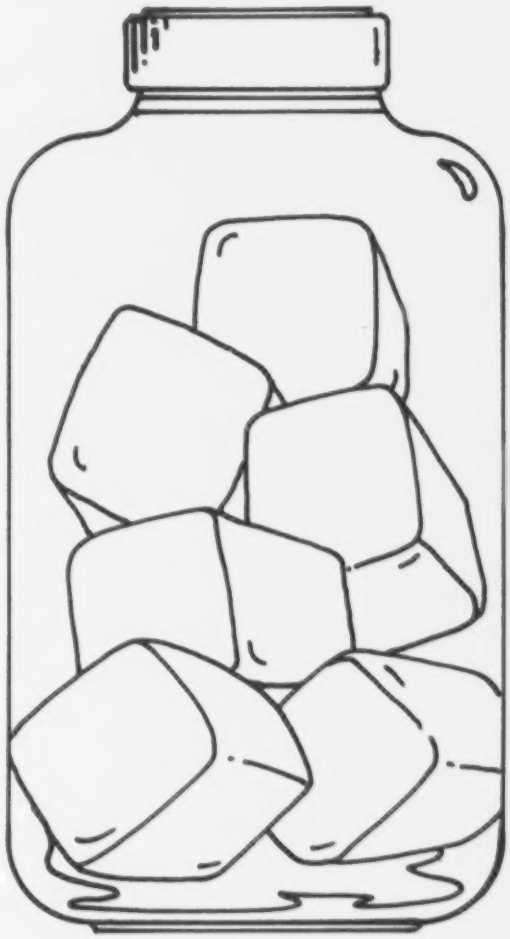
MAKING THE BEST INSULATOR

Name _____

Date _____

Invent an insulation system to keep ice or ice cubes frozen in a glass with a lid. Measure temperature every 15 minutes to evaluate which invention is most effective. Materials that can be tried are: packing material, cloth, styrofoam, cardboard, newspaper, etc.



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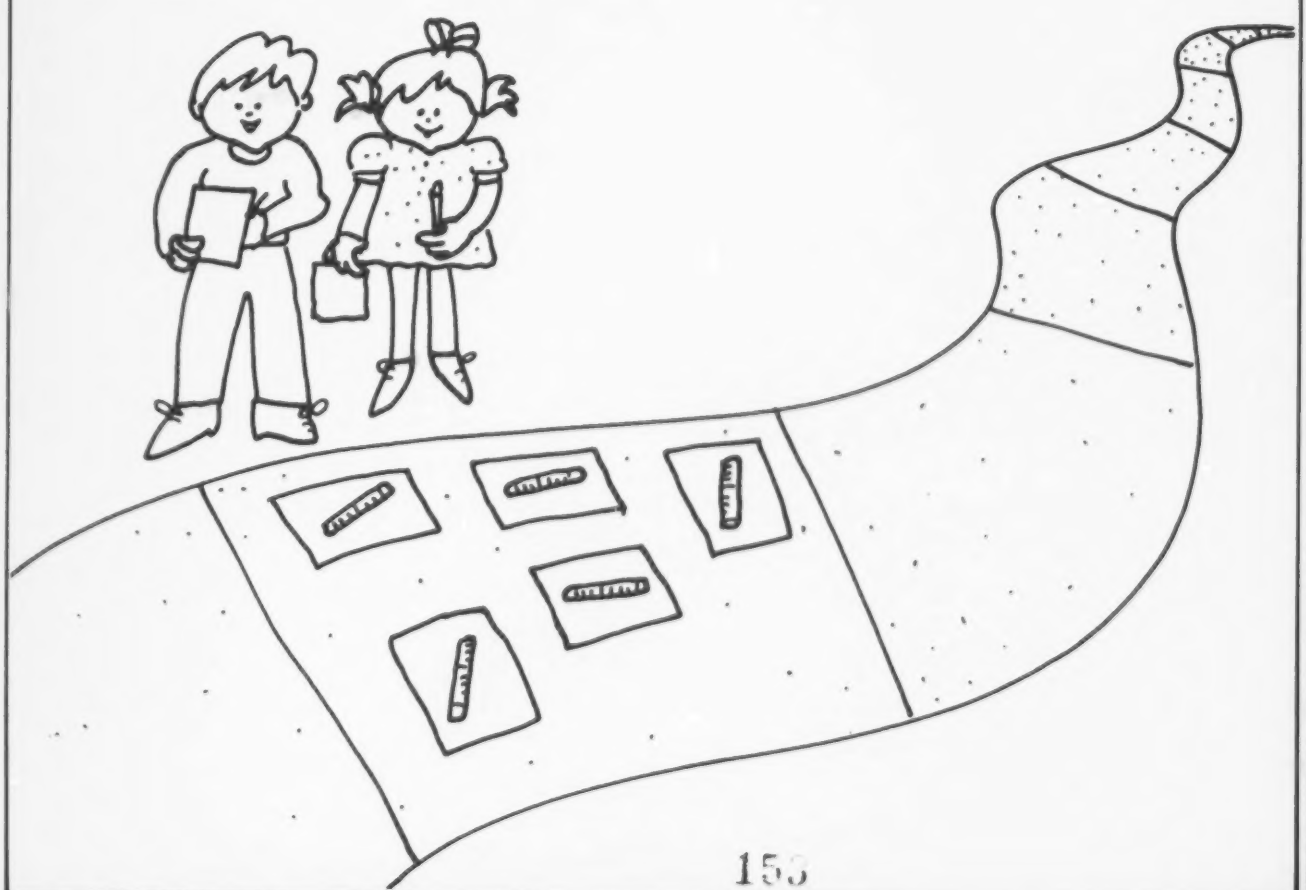
WHICH COLOR IS THE BEST SOLAR INSULATOR?

Name _____

Date _____

Pick a sunny day. Place five different colors of 9x12 construction paper on the sidewalk. After 10 minutes, place a thermometer on each one. Take the temperature after another 2 minutes and record the results. Discuss your findings. What conclusions can you make? Try to duplicate the experiment with different colors—how were the results different?

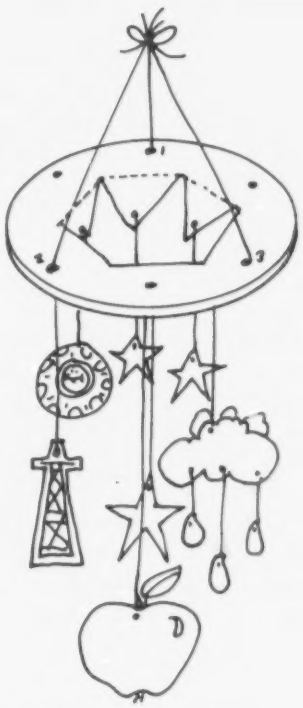


ENERGY MOBILES

Name _____

Date _____

Create your own energy mobile by following the directions below.



Materials

1 set of energy mobile parts
2 yards of string
cardboard or tagboard
crayons
scissors
glue

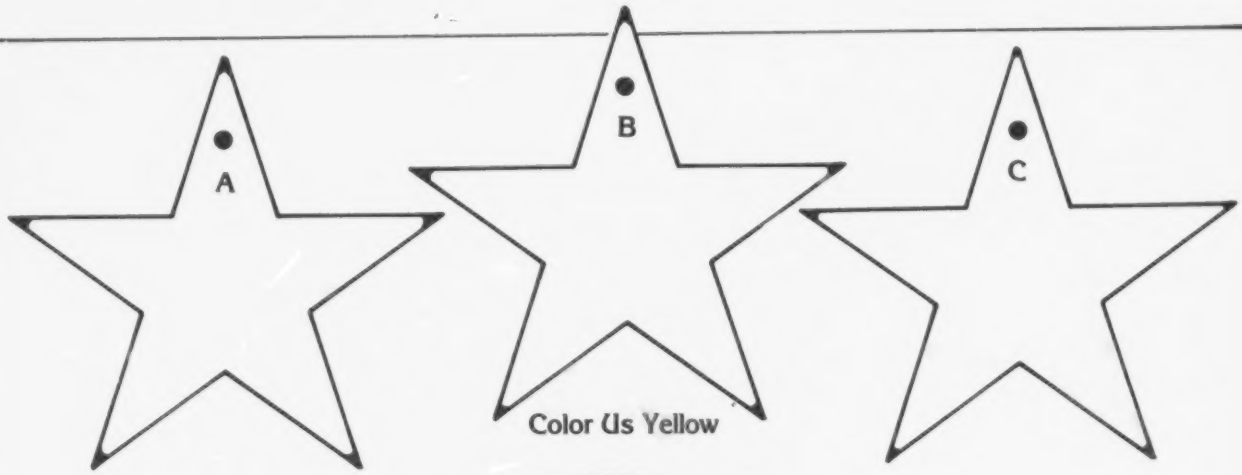
Directions

1. Color all parts for your mobile.
2. Cut out all of the parts. Glue main circle to cardboard so it will be sturdy.
3. Carefully punch small holes through the dots on the mobile parts.
4. From your piece of string, cut three, six-inch pieces. Tie these onto holes 1, 2 and 3. Then tie the three strings at the top. This creates the mobile circle.
5. Using the rest of your string, cut string into different lengths and attach the mobile pieces to the mobile circle. Be sure to match the letters and numbers.
6. From point number 6, attach a picture of your own that shows another energy source.
7. Try to balance your mobile by changing the length of your strings.

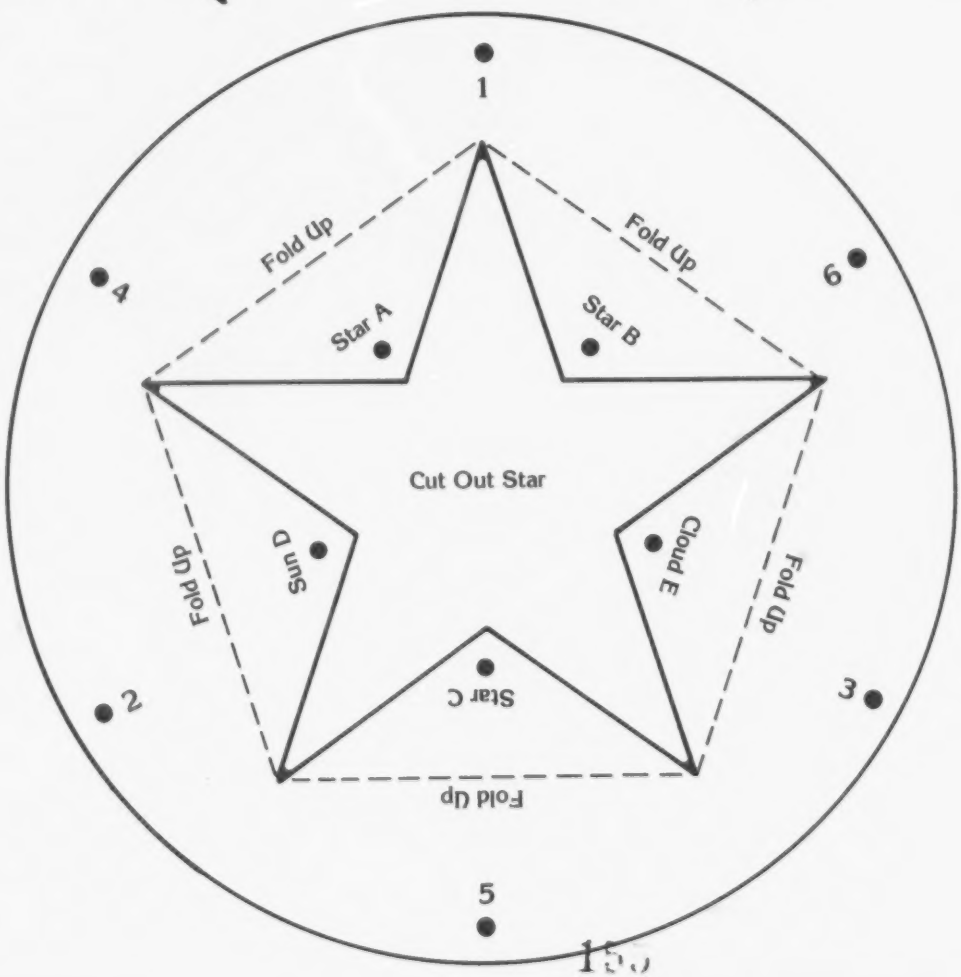
ENERGY MOBILE I

Name _____

Date _____



Color Us Yellow



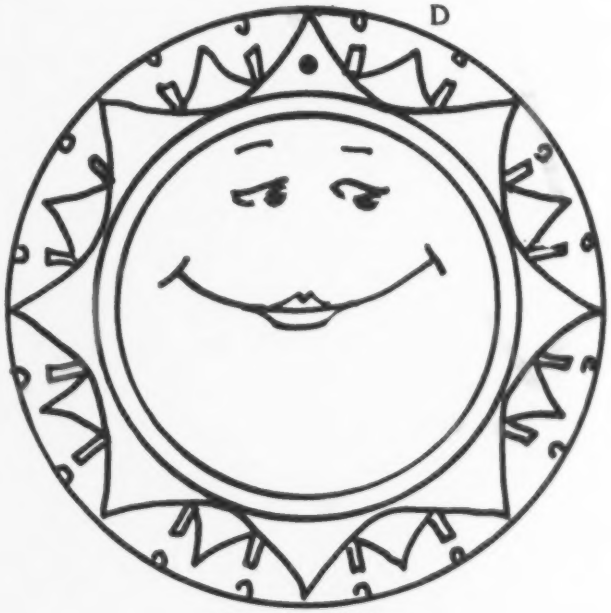
ENERGY MOBILE II

Name _____

Date _____

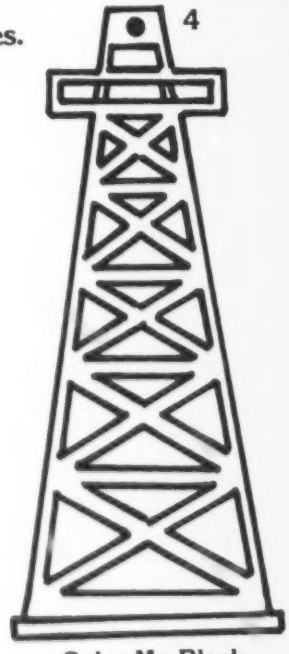
Note to Teacher: Run copies on tagboard for more durable mobiles.

D



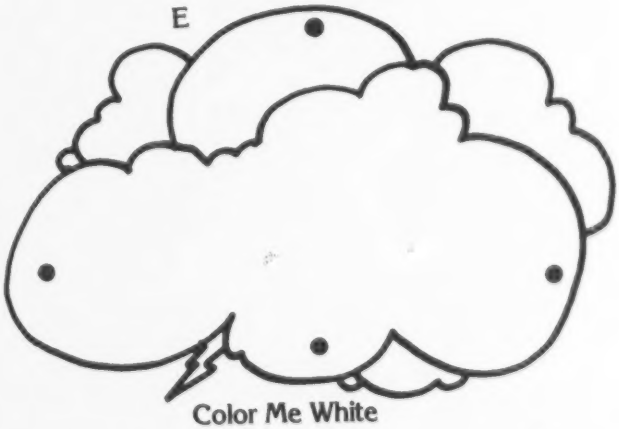
Color Me Yellow

4



Color Me Black

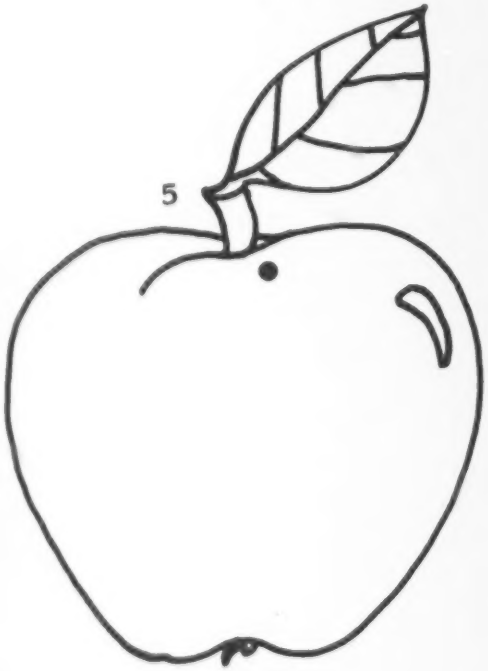
E



Color Me White

Color Us Blue

5



Color Me Red

156

KEY TO THE FUTURE

Name _____

Date _____

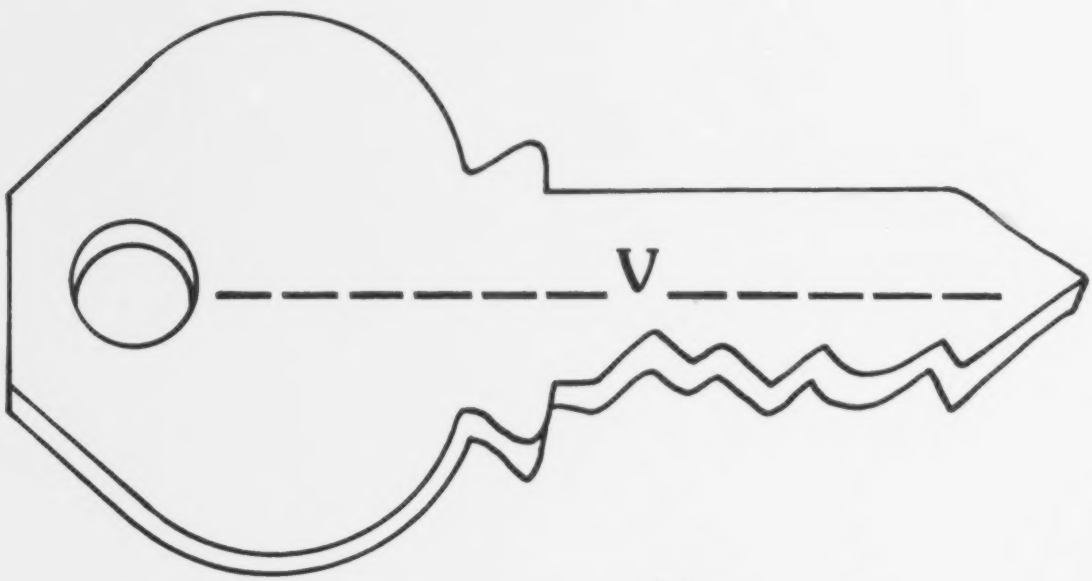
Complete the following list of energy sources by filling in the missing letter in each word:

ENERGY SOURCES

1. o__l
2. ___oal
3. ___uclear
4. natur___l gas
5. hydroelec___ric
6. wi___d
7. geothe___mal
8. ___olar
9. ___il shale
10. wo___d
11. tid___s

Now unscramble the underlined letters to form the answer to the riddle.

What is the key to the future?



157

I AM AN ENERGY SAVER

Name _____

Date _____

Are you an Energy Saver?
Unscramble the following sentences and find out.

1. WATER I WASTE DON'T HOT.
2. I ROOM THE WHEN LEAVE TURN LIGHTS THE I OUT.
3. I'M OFF IT TELEVISION WATCHING THE TURN WHEN NOT I.
4. RIDE USING INSTEAD THE WALK SHORT FOR MY OR TRIPS BICYCLE CAR OF I.
5. THE DON'T I'M LISTENING I ON WHEN RADIO LEAVE NOT STEREO OR.

Rewrite the sentences on the lines below:

_____

_____

_____

_____

_____

_____

_____

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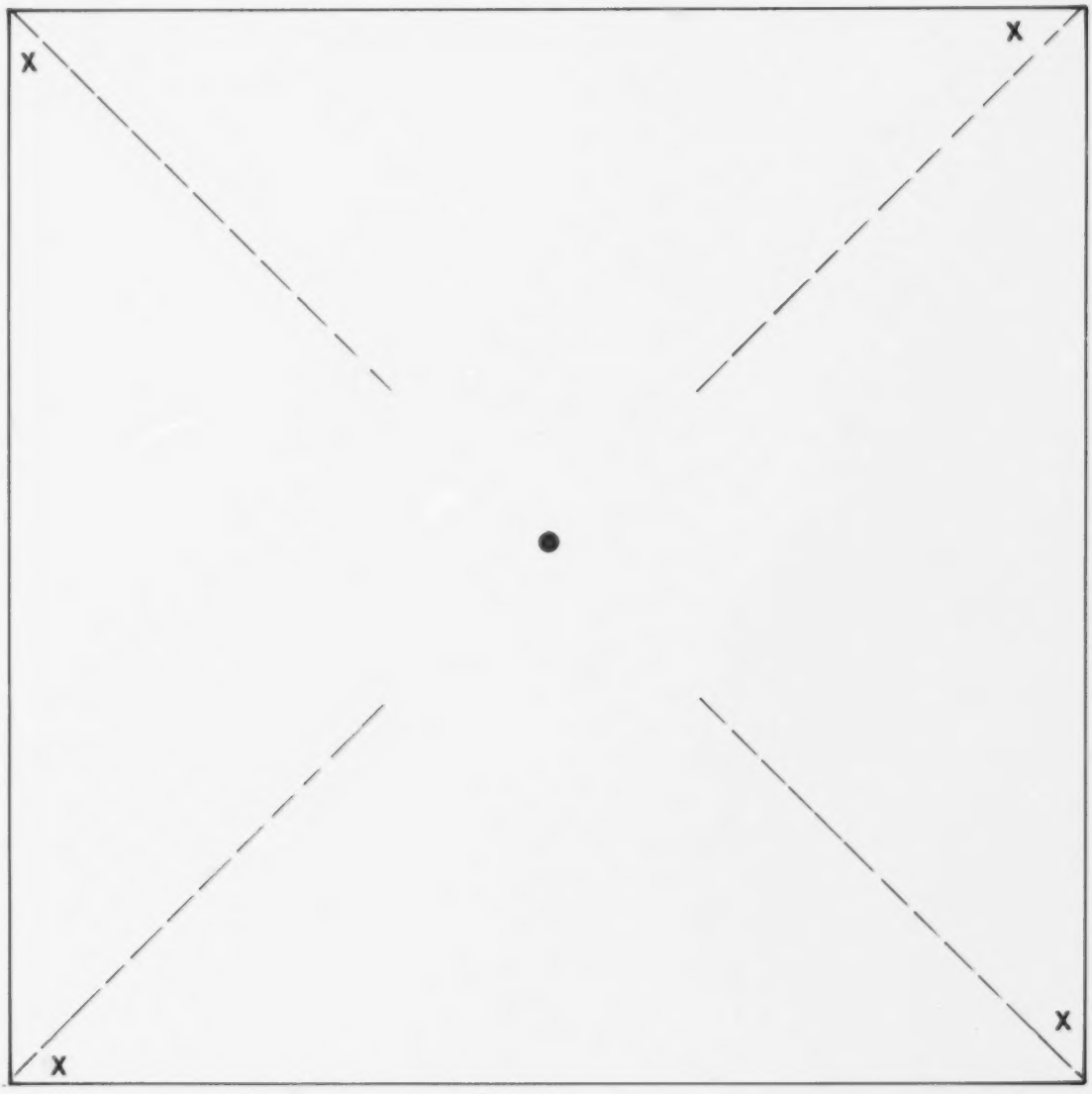
MAKE A WIND WHEEL

Name _____

Date _____



Materials: scissors, pins, pencils or straws

1. Cut in at each corner.
2. Take the corners marked X and fold up to center.
3. Pin all corners to the center.
4. Pin on eraser of pencil or plastic straw.

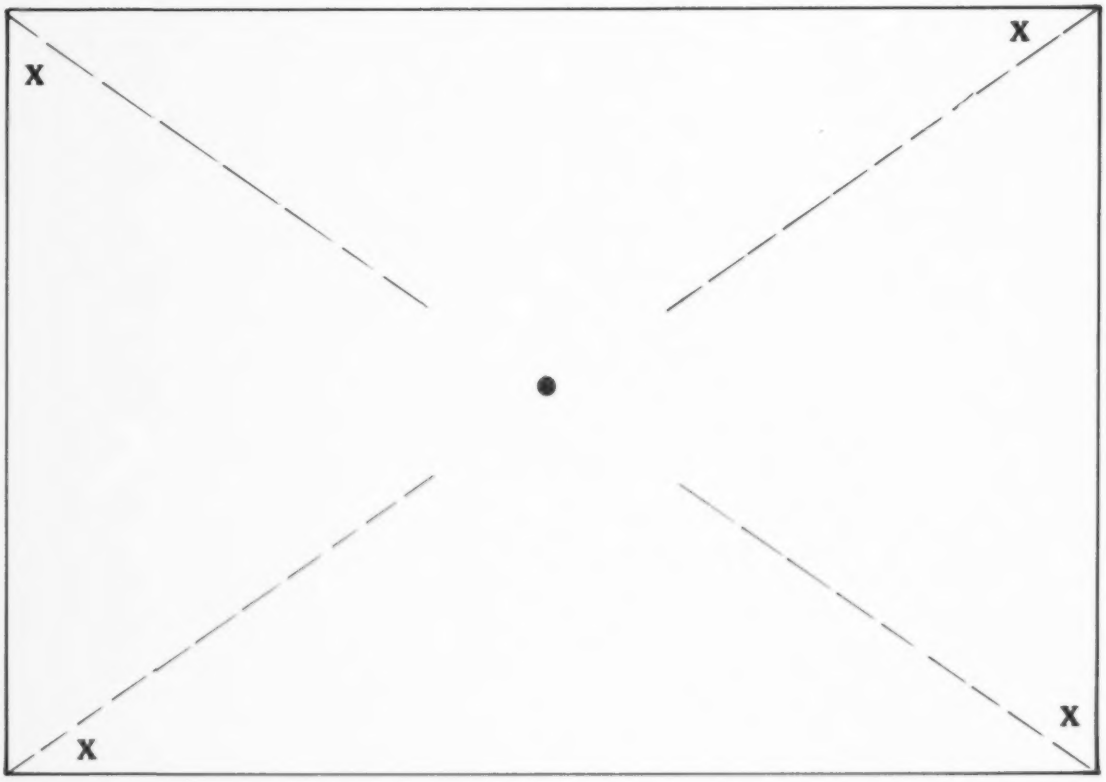
Teacher: Run this on heavy paper such as oaktag.

Your wind wheel should look like this:

A WIND WHEEL OF ANOTHER SHAPE

Name _____

Date _____



Materials: scissors, pins, pencils or straws

1. Make a wind wheel (pin wheel) that is a rectangle, not a square.
2. Make it the same way you made the square wind wheel.
3. Does this wind wheel work like the square wind wheel? Why or why not?
4. Design a new wind wheel out of another shape. Predict how well it will work. Try it out.

Teacher: Run this on heavy paper such as oaktag.

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Energy Glossary

A

Acid Rain

Any form of precipitation having a pH less than 5.6 on a scale of 0-14. Pure water (pH 5.6) becomes acidic through the addition of chemicals from natural or man-made sources.

Air Pollution

The presence of contaminants in the air in concentrations that prevent the normal ability of the air to clean itself, and that interfere directly or indirectly with the health, safety or comfort of organisms, or with the full use and enjoyment of property.

Alternating Current (AC)

An electric current with its direction reversed at regular intervals. Electric current in the U.S. alternates with a frequency of 60 hertz, or cycles per second. Some European countries use 50 hertz.

Ampere

A unit of measure of electric current. One ampere equals 6.2×10^{18} electrons passing a point in 1 second.

Ash

The residue which remains after complete burning (or oxidation) of a combustible material.

B

Boiler

Equipment which burns fuel or collects the sun's rays. Creates high temperatures to convert water to steam in order to produce electricity.

Boiling

Heated to the boiling point; the temperature at which a liquid generates bubbles and converts to vapor.

C

Calorie (cal.)

(1) A unit of heat energy equal to the amount of heat that will raise the temperature of one gram of water one degree Celsius. The calorie is used when temperature is measured on the Celsius scale, while the British Thermal Unit is used when the measurement is on the Fahrenheit scale. One calorie equals 4.18 joules. (2) An amount of food having the energy-producing value of one calorie.

162

Carnivore

An organism that obtains its food energy by eating animals.

Caulking

The filling of cracks with a solid material such as plastic.

Circuit

The complete path travelled by an electric current.

Circuit Breaker

An automatic switch which breaks the circuit when too much electric current is flowing. It is similar to a fuse, but can be reused or reset.

Coal

A solid, combustible, organic hydrocarbon formed by the decomposition of vegetable material without free access to air.

Conductor (Electrical)

A material capable of carrying an electrical current.

Conservation of Matter and Energy (Law of)

The total amount of energy and matter in the universe remains constant.

Conserve

To manage or use wisely.

Consumers

(1) A person or thing that consumes; specifically, a person who buys goods or services for his/her own needs. (2) Organisms that get their energy by eating other organisms; the second trophic level on an ecological pyramid.

Conversion

The process of altering the physical or chemical nature of a substance. Processes such as cracking and polymerization can produce increased quantities or qualities of substances from basic fuel. Also, conversion can refer to the use of one energy source to produce another, such as gas used to produce electricity.

D

Demand, Electric

The requirement for electric power to be delivered by a system at a given instant, or averaged over any designated period of time, expressed in kilowatts or other suitable units.

Direct Current (DC)

An electric current that flows in only one direction through a circuit, as from a battery.

E

Ecology

The interrelationships of living things to one another and to their environment or the study of such interrelationships.

Electric Current

A flow of electrically charged particles along a conductor.

Electric Energy

The energy associated with electric charges and their movements. Measured in watt hours or kilowatt hours. One watt hour equals 3600 joules or 860 calories.

Electricity, Current

The flow of charged particles (electrons) through a conductor.

Electricity, Static

Free charged particles (electrons) not in motion.

Electron

A subatomic particle with a negative electrical charge, a small diameter and a mass 1/1837 that of a proton. Every atom consists of one nucleus and one or more electrons.

Energy Conservation

The practice of extending the useful life of the earth's energy resources through wise and efficient management.

Entropy

A measure (thermodynamic) of disorder or unavailability of energy. A highly ordered system has a small value of entropy; a highly disordered system has a large value of entropy. Any use or conversion of energy irreversibly degrades its entropy, resulting in less energy available of the same quality.

F

Fission

The splitting of a heavy atom into two parts. This splitting releases large amounts of energy and one or more neutrons.

Food Chain (Food Web)

A sequence of organisms, including producers, herbivores, and carnivores, through which energy and materials move within an ecosystem.

Fossil Fuels

Coal, oil, natural gas, and other fuels originating from geologic deposits of ancient plant and animal life. These fuels depend on oxidation for release of energy.

Fuel Cell

A device in which fuel and oxygen are combined to produce chemical energy that is converted directly into electrical energy.

Fusion, Nuclear

A nuclear reaction involving the combination of smaller atomic nuclei into larger ones with the release of energy. This process is also called a thermonuclear reaction because of the extremely high temperature required to initiate it.

G

Generation

(1) The act or process of producing electric energy from other forms of energy. (2) The amount of electric energy so produced.

Generator

A device that converts mechanical energy into electrical energy. For example, the energy from falling water or steam may be used to spin a turbine that turns a coil of wire in the presence of a magnetic field which thus produces an electric current.

Greenhouse Effect

The heat effect of the atmosphere upon the earth. Light waves from the sun pass through the air and are absorbed by the earth. The earth then reradiates this energy as heat waves that are absorbed by the air, specifically by carbon dioxide. The air behaves like glass in a greenhouse, allowing the passage of light but not of heat. Thus, many scientists theorize that an increase in the atmosphere concentration of CO_2 can eventually cause an increase in the earth's surface temperature. Greenhouse effect also means a method of using solar radiation to warm underheated areas.

H

Habitat

The sum total of environmental conditions of a specific place that is occupied by an organism, a population or a community.

Heat

Molecular kinetic energy transferred from one object to another or obtained by conversion from another form of energy (as in conversion from electrical or chemical energy). Heat is usually measured in calories, but in space by the British Thermal Unit (BTUs).

Heat Energy

Energy that causes an increase in the temperature of an object, or changes the object from solid to liquid or from liquid to gas.

Herbivore

An organism that eats plants to obtain food energy.

Hydroelectricity

Electric energy produced by water-powered turbine generator.

Hydroelectric Plant (Conventional)

A hydroelectric power plant which utilizes streamflow only once as the water passes downstream. In this respect it differs from the pumped-storage plant which recirculates all or a portion of the streamflow in the production of power.

Hydroelectric Plant (Pumped-Storage)

A hydroelectric power plant which recirculates all or a portion of the streamflow in the production of power.

Hydropower

Power produced by falling water.

I

Insulation

Any material that provides a high resistance to the flow of heat, sound, or electricity from one surface or area to another.

J

Joule

A metric unit of work or energy; the energy produced by a force of one newton operating through a distance of one meter. Equivalent to one watt second. An exajoule is equal to 10^{18} watts; estimated conventional gas resources are said to equal 10,500 exajoules.

K

Kilowatt (kW)

A unit of power, usually used for electric power (equal to 1000 watts), or to energy consumption (at a rate of 1000 joules per second). Roughly, a power of 1 kW is capable of raising the temperature of a pound (pint) of water 1°F in one second.

Kilowatt-Hour (kWh)

The amount of work or energy delivered during the steady consumption of 1 kilowatt of power for a period of one hour. Equivalent to about 853 calories of heat energy.

Kinetic Energy

Energy possessed by objects in motion.

L

Light Energy

The kind of energy that travels as visible radiation. For example, photons.

Load

The power and energy requirements of users on the electric power system in a designated area or the amount of power delivered to a given point.

M

Mechanical Energy

The energy of motion used to perform work.

Motor

A machine which converts electrical energy into mechanical energy or which does work.

N

Natural Gas

An odorless, colorless, tasteless, non-toxic, clean-burning fossil fuel, natural gas is largely CH_4 (methane), a naturally occurring hydrocarbon that can also be produced synthetically as by coal gasification. At times it contains ethane, propane, butane, pentane, helium, and hexane.

Neutron

An uncharged elementary particle that has a mass nearly equal to that of the proton. Present in all known atomic nuclei except the hydrogen nucleus, neutrons are the particles that sustain a chain reaction in a nuclear reactor.

Non-Renewable Resources

Depletable energy resources such as the fossil fuels — coal, gas, and oil.

Nuclear Energy

Energy that can be produced by changes in the nucleus of an atom as by fission of a heavy nucleus or by fusion of light nuclei into heavy ones with accompanying loss of mass.

Nucleus

A dense central core of the atom in which most of the mass and all of the positive charge is concentrated.

Nutrient

Elements or compounds essential as raw materials for organism growth and development. For example, nutrients are carbon, oxygen, nitrogen, and phosphorus. Classes of nutrients in food are carbohydrates, fats, proteins, vitamins, minerals and water.

O

Oil

Any of the various kinds of greasy combustible substances obtained from animal, vegetable, and mineral sources. Oils are liquid at ordinary temperatures and soluble in certain organic solvents, but not in water. Synonym: petroleum.

Ohm

The unit of measure of electrical resistance. One volt will force a current of one ampere through a resistance of one ohm.

P

Peak Load

The maximum amount of power delivered during the stated period of time. The term is sometimes used to describe that portion of the load above the base load.

Petroleum (Crude Oil)

A naturally occurring material (gaseous, liquid, or solid) composed mainly of chemical compounds of carbon and hydrogen. Fractional distillation yields gasoline, diesel, lubricating oil, and other products.

pH

A way of expressing both acidity and alkalinity on a scale of 0-14, with 7 representing neutrality, numbers less than 7 increasing acidity, and numbers greater than 7 increasing alkalinity.

Photosynthesis

The process in which sunlight falling on green plants causes carbon dioxide and water to be converted into more complex organic materials such as glucose. Thus, it is the process by which green plants convert radiant energy into chemical energy.

Potential Energy (Electrical)

The amount of voltage capable of moving an electric charge from one point to another.

Power

The rate at which work is done or energy expended. It is measured in units of energy per unit of time, such as calories per second, and in units such as watts and horsepower. If an amount of work (W) is done over a period of time (t) the power or rate of doing work is P=W/t.

Producers

Organisms that utilize light energy to produce usable chemical energy; i.e., plants, autotrophs. Producers are the first trophic level on a pyramid of energy.

166

Proton

An elementary particle found in the nucleus of all atoms. It carries a positive charge equal to the negative charge of the electron. The proton is, in effect, the positive nucleus of the hydrogen atom.

R

Radiant Energy

Any form of energy radiating from a source; i.e., sound, heat, electromagnetic waves, light, x-rays, gamma rays, etc.

Radiation

Any high-speed transmission of energy in the form of particles or electromagnetic waves.

Recycle

To process what are often waste materials (i.e., liquid body waste, cans, glass, newsapers) in order to regain new material for human use.

S

Solar, Active System

Energy from the sun used to generate electricity and to

produce liquid or gaseous fuels. Active solar systems include windmills, hydroelectric energy, solar thermal energy conversion, biomass, ocean thermal energy conversion, and satellite power systems.

Solar Battery

A device of one or more units for converting the energy of sunlight into electrical energy.

Solar Cell

An electric cell which converts radiant energy from the sun into electrical energy by the photovoltaic process.

Solar Collector

A surface which by virtue of geometry or surface properties absorbs solar energy and imparts this energy to a heat-transfer fluid which circulates through the collector.

Solar, Passive System

A means of capturing, storing, and using heat from the sun. Unlike active systems, passive solar systems do not require the use of pumps and controls.

Solar Energy

Radiation energy from the sun falling upon the earth's surface.

Sound Energy

A type of energy in which waves are carried by the transmission of mechanical vibrations through air, water, or solids.

Static Electricity

Unbalanced, stationary electric charges.

Storm Door

An additional door with an air space between it and the existing door.

Storm Window

An additional window with an air space between it and the existing window. Storm windows will cut in half the heat that passes through windows in a house.

Substation

An electrical power station which serves as a control and transfer point in an electrical transmission system.

Superconductor

A material which, when cooled near absolute zero, has no electrical resistance. Superconducting transmission lines can carry electrical power without loss. Superconducting coils can store large amounts of electrical energy.

T

Thermal Energy

The total potential and kinetic energy associated with the random motions of the particles of a material.

Transformer

A device which can increase or decrease the voltage of an alternating current.

Transmission

The act or process of transporting electric energy in bulk from a source or sources of supply to other utility systems. It is done at high voltage to reduce loss.

Turbine

A rotary engine powered by a jet of steam or fluid usually. It generates electricity. Natural gas provides about 25% of the initial fuel.

V

Volt

A unit of electrical pressure which forces electrical charges to move through conductors. One volt will force one ampere of current to move through a resistance of one ohm.

W

Water Pollution

The addition of sewage, industrial, and institutional wastes or other harmful or objectionable material to water in concentration, or in sufficient quantities to result in measurable degradation of water quality.

Watt

A metric unit of power, usually used in electric measurements, which gives the rate at which work is done or energy expended. One watt equals one joule of work per second. Stated in another manner, one watt is the work done when an electrical force of one volt pushes 6×10^{18} electrons through a resistance of one ohm in one second.

Windmill

A machine for doing useful work utilizing the energy of wind.

Work

The transfer of force from one body or system to another. Work is performed by a force moving an object.